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# he fishery for the lorway lobster, *Nephrops norvegicus* (L.), ff the north-east coast of England

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# Abstract

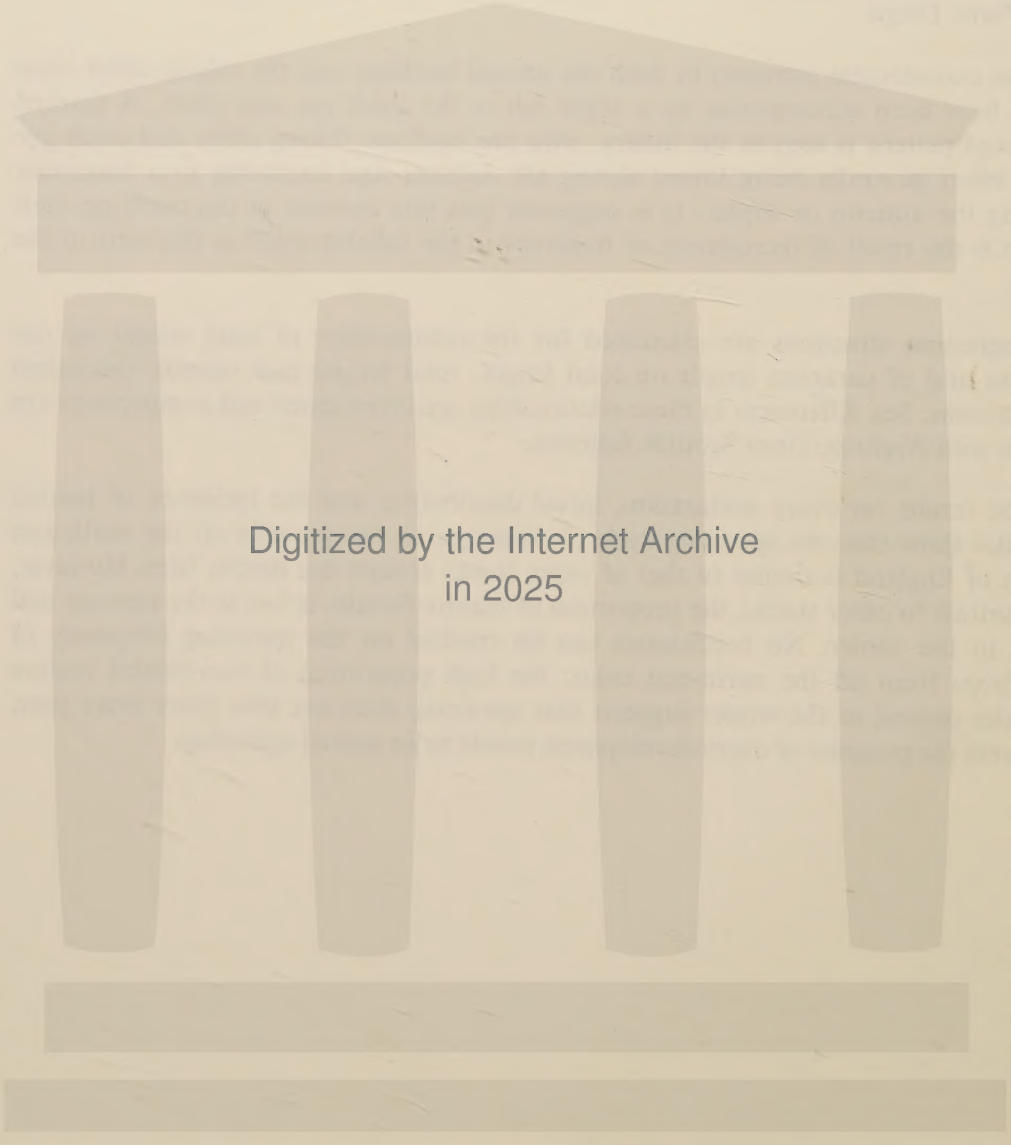
Information on the *Nephrops* fishery off the north-east coast of England, collected from the commercial fishery and by research vessel sampling, has been brought together and analysed.

The fishery is based mainly on North Shields although in recent years Scottish vessels have made substantial landings at English ports north of North Shields. Research vessel surveys show that the main concentrations of *Nephrops* are within the 40 fathom (approximately 73 metre) contour of the depression extending southwards from the Farne Deeps.

The considerable increases in both the annual landings and the fishing effort since 1963 have been accompanied by a slight fall in the catch per unit effort. A marked seasonal pattern is seen in the fishery, with the landings, fishing effort and catch per unit effort generally being lowest during the summer and increasing to a maximum during the autumn or winter. It is suggested that this increase in the catch per unit effort is the result of recruitment of *Nephrops* to the fishable stock at this time of the year.

Regression equations are calculated for the relationships of total weight on tail weight and of carapace length on total length, total weight and various abdominal dimensions. Sex differences in these relationships are investigated and comparisons are made with *Nephrops* from Scottish fisheries.

The results on ovary maturation, larval distribution and the incidence of berried females show that the spawning cycle of *Nephrops* on the grounds off the north-east coast of England is similar to that of other stocks around the British Isles. However, in contrast to other stocks, the proportion of mature females is low in the summer and high in the winter. No conclusions can be reached on the spawning frequency of *Nephrops* from off the north-east coast; the high proportion of non-berried mature females present in the winter suggests that spawning does not take place every year, whereas the progress of ovary development points to an annual spawning.



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# ntroduction

*Nephrops norvegicus* (L.) occurs mainly in European ters, having a wide distribution from the north coast of rway and Iceland to the Mediterranean. In British waters forms commercially exploitable populations in several as, particularly around the Scottish mainland (Thomas 65). The most important fishery for English vessels is uated off the Northumberland coast of north-east England, d the purpose of this paper is to bring together and ana- e data relating to this fishery collected over a number of ars. Previous published work on this fishery is limited; orrow (1912, 1913) reported on the commercial fishery d gave details of *Nephrops* sampling both on the fish arket and at sea. and Cole (1965) compared the length stributions of *Nephrops* with those from other areas fished vessels from England and Wales.

# Materials and Methods

A programme of market sampling of *Nephrops* has been operation at North Shields since 1962 and this has pro- ided information on the carapace length compositions of ne landings at this port. In addition, since 1962, a monthly ample of *Nephrops* (about 3 stones, or 19 kg), normally aken straight from the trawl on a commercial vessel, has een dispatched direct to the Fisheries Laboratory, Lowe- toft where it has been analysed to give data on carapace ength, total weight and female maturity. Cruises by re- earch vessels since 1959 in this area have provided informa- ion on the distribution of the *Nephrops* stocks and addi- ional data on size composition, etc.

Acknowledgement is due to the staff of the MAFF fishery ffice at North Shields for the collection of samples and for nformation regarding the commercial fishery.

# esults

## COMMERCIAL FISHERY

### *its and gear*

The present fishery for *Nephrops* off the north-east coast England is based mainly on North Shields, although quite stantial landings have been made since 1966 at the smaller ts of Seahouses (North Sunderland), Amble, Blyth and rtlepool. The fishing is by trawlers ranging in size from to 65 feet, or approximately 12 to 20 m (averaging about feet, or 15 m), with a few landings being made by al seiners and foreign vessels. In recent years the tendency been for the main effort to be concentrated on *Nephrops* ring the last and/or first quarters of the year and, when ing is at its peak, up to 30 local vessels work from North elds and a similar number from the smaller ports. In dition, up to 60 visiting Scottish vessels, mainly from the th of Forth, also work off the north-east coast of England d land at English ports at this time of the year. Landings visiting vessels are of far greater importance at ports to north of North Shields, contributing in 1969, for in-nce, 77 per cent to the total landings at Amble, 95 per nt at Blyth and 31 per cent at North Shields.

The gear used by local vessels in this fishery is an otter wl with a light groundrope, essentially the same net being ed for catching whitefish when *Nephrops* fishing is slack sually during the summer months). The tendency is, how-er, to tow more slowly when fishing for *Nephrops*. In neral, the length of the ground-rope is between 118 and 5 feet (35 and 38 m), the head-line being 12 feet (3.7 m) orter. The mesh sizes are normally uniform throughout e net at 70 mm, although in a few cases a larger mesh is ed in the wings.

### *istribution and abundance of* Nephrops

The *Nephrops* grounds worked most frequently by vessels om North Shields are from 10 to 15 miles (16 to 24 km) om the coast adjacent to the R. Tyne, but a northerly ex-nsion of these grounds is worked by vessels from the other orts. The summer fishery for whitefish when *Nephrops* are arce is also centred in this same area, although a few of the rger vessels may venture further afield.

The distribution of *Nephrops* in this area, as determined om the catches of research vessels, is shown in Figure 1 hich gives in (A) the number of *Nephrops* caught per 1 our's fishing by RV PLATESSA in June 1959 and RV ONAWAY July 1959 (with contours drawn at 25, 100 and 200 *Neph-ps* per 1 hour's fishing), and in (B) the number of *Nephrops* er ½ hour's fishing caught by RV TELLINA in October 1969 ith contours at 100, 200, 500 and 1 000 *Nephrops* per hour's fishing). All the vessels were using trawls having ther a small-meshed cod-end or a small-meshed cover on e cod-end. No correction has been applied to take account the variations in the catches of *Nephrops* between hauls ade at different times of the day (Simpson 1965).

The density of *Nephrops* found during the later (October 969) cruise was much higher, up to 15 times greater at the aximum densities, than on the earlier cruises (June and July 1959). The main concentrations of *Nephrops*, however, were in both cases within the 40 fm (73 m) contour of the deep water extending southwards from the Farne Deeps, with very few *Nephrops* being caught on its eastern and western edges. It is apparent that the centre of concentration was much further south in October 1969 than in June and July 1959.

It is not clear why such differences were found in the abundance and distribution of *Nephrops* on the North Shields grounds, but the timing of the cruises may have had an important bearing on the results, and it may be that there are large seasonal and/or annual variations in catches. The PLATESSA and ONAWAY cruises took place in June and July, months when catch rates by commercial vessels are normally low, whereas the TELLINA cruise was in October, during the height of the fishing season. In addition, the two earlier cruises took place in 1959, the year before the present expansion of the fishery, and changes may have taken place in the distribution of *Nephrops* as the result of heavy exploitation during the ten years which elapsed between these and the cruise by TELLINA in 1969.

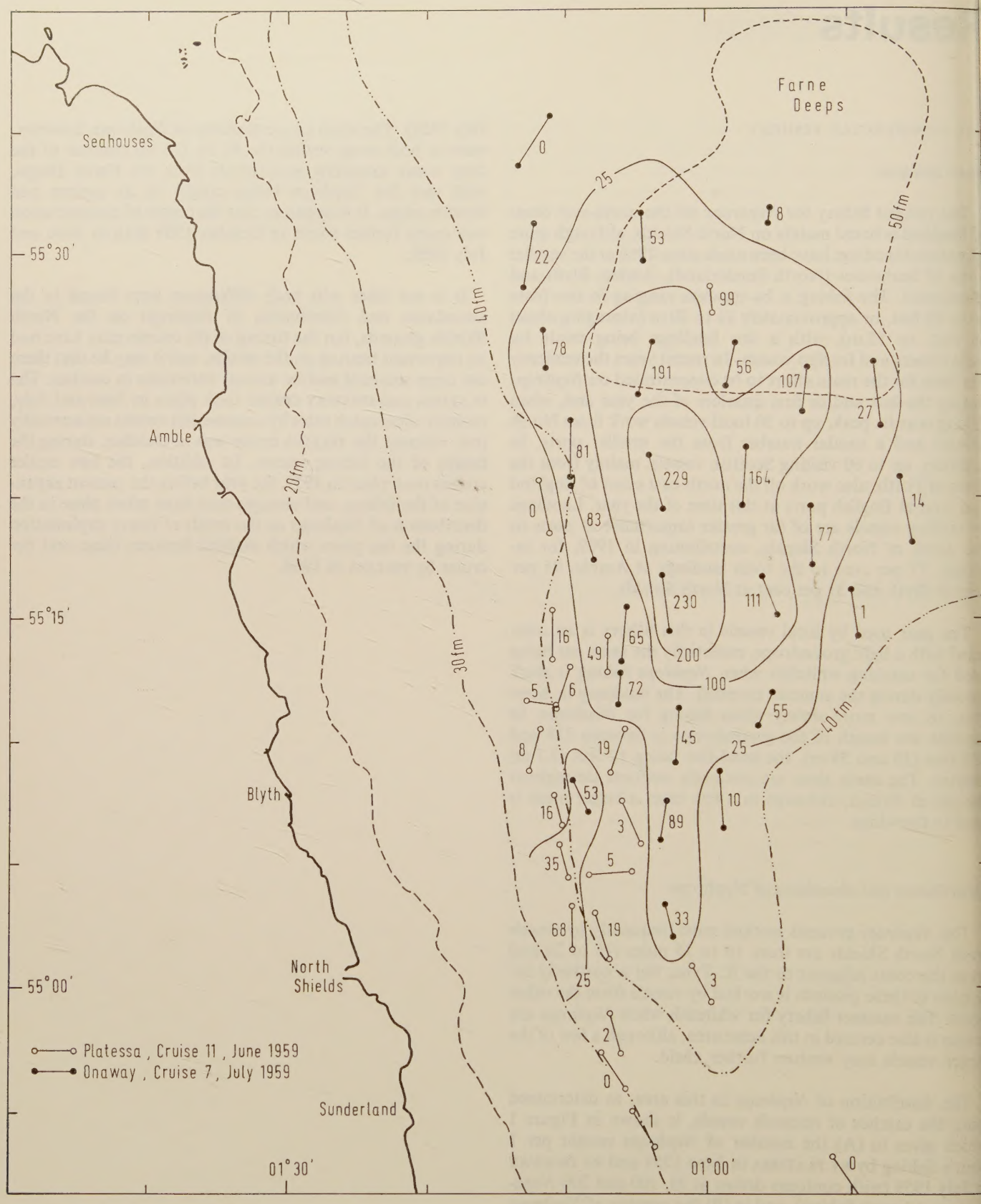
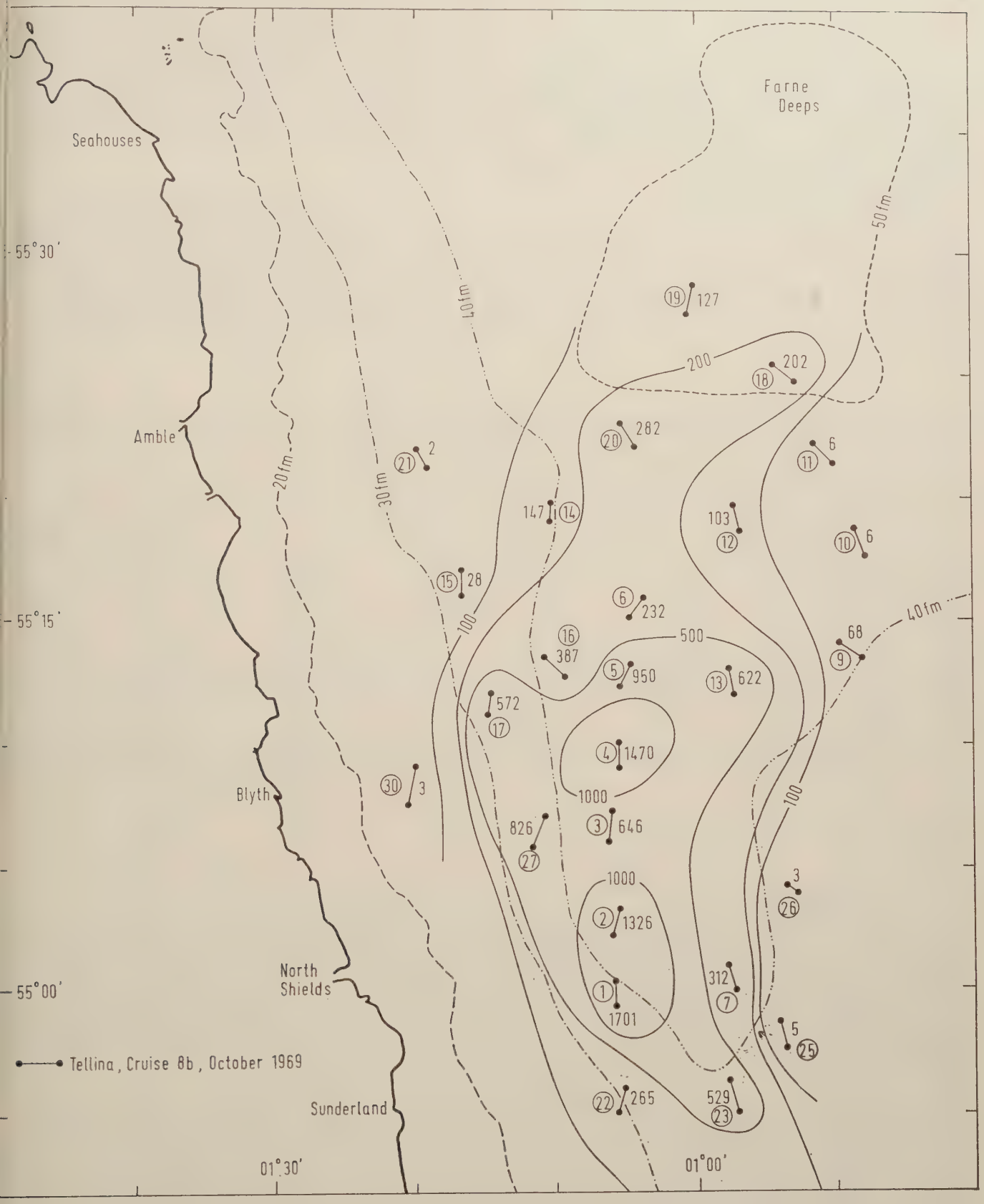



Fig. 1 Distribution of *Nephrops* on the North Shields grounds as determined from research vessel sampling: (A) PLATESSA Jun 1959, and ONAWAY July 1959; (B) TELLINA October 1969. Station numbers given in circles.


Farne
Deeps
Seahouses
Amble
Blyth
North
Shields
Sunderland
55°30'
55°15'
55°00'
01°30'
01°00'
20fm
30fm
40fm
50fm
100
200
500
1000
19 127
18 202
20 282
11 6
21 2
14 147
12 103
10 6
15 28
6 232
16 387
5 950
13 622
9 68
17 572
4 1470
30 3
3 646
27 826
2 1326
26 3
1 1701
7 312
25 5
22 265
23 529
Tellina, Cruise 8b, October 1969

Nephrops *landings and effort*

The annual landings since 1926 at each north-east port are given in Table 1, and the landings at North Shields from 1895 to 1911 (data from Storrow 1912) and the landings in north-east England since 1926 are shown in Figure 2. Also shown are the total landings at ports other than those in north-east England and the total landings in England and Wales since 1926.

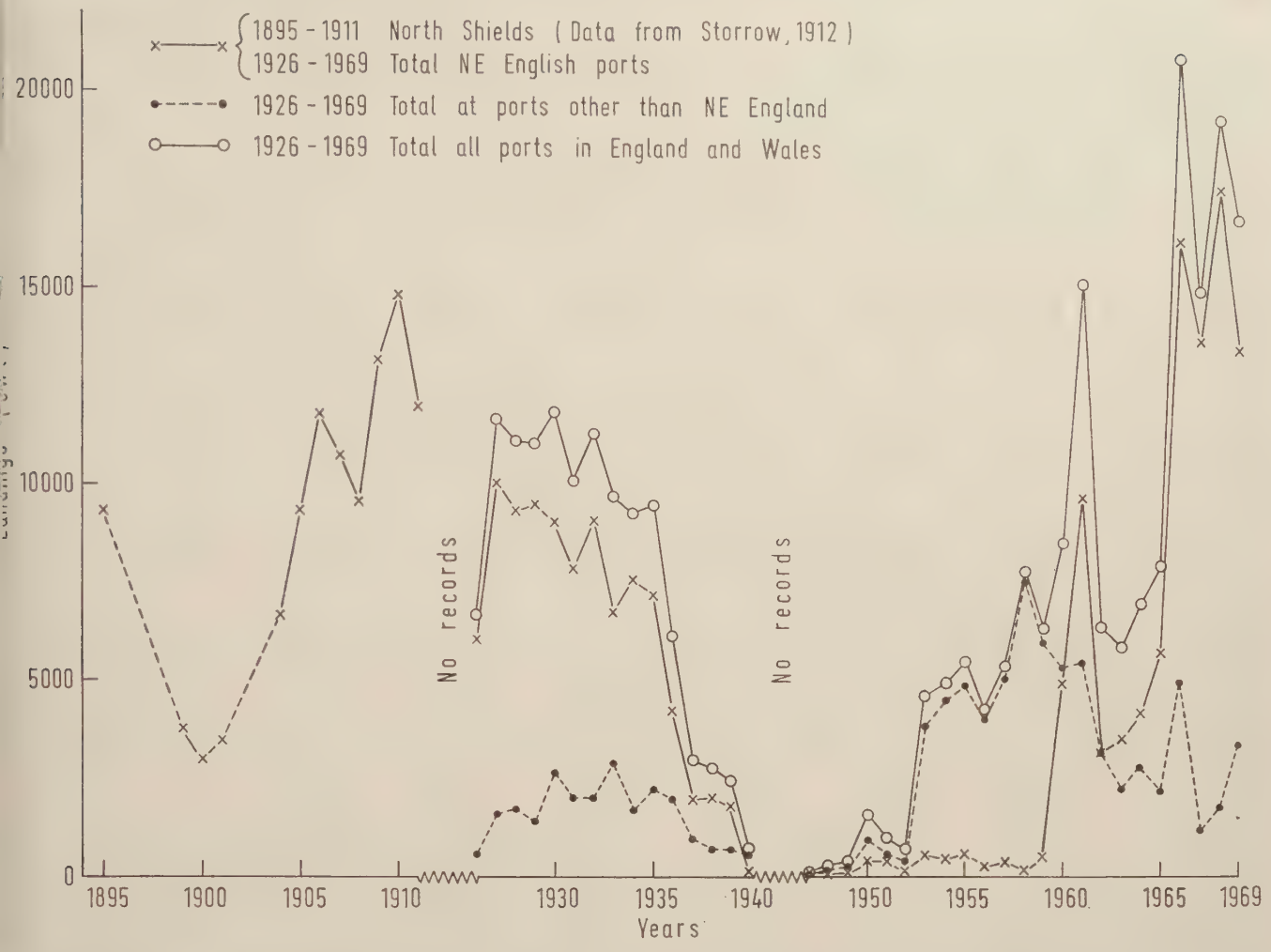
The landings at North Shields in the early years of this century rose steadily to nearly 15 000 cwt in 1910. No records are available from 1912 to 1925 inclusive, but a gradual decline in the fishery from the north-east ports (mainly North Shields and Sunderland) took place until landings were only about 2 000 cwt per annum in the late 1930s. It is not known whether the fluctuations in the fishery from 1895 to 1940 were due to changes in effort or to changes in the abundance of *Nephrops*, but the lower annual landings at North Shields in the 1920s (Table 1) compared with those before the First World War may have been the result of decreased effort, due to trawlers lost in action not being replaced after the war.

After the Second World War, the landings remained at a very low level until 1960 when there was a rapid expansion of the fishery, with the total landings at the north-east ports reaching 17 600 cwt in 1968. Although North Shields has remained the main port of landing, the period 1966 to 1969 saw the development of the fishery at the smaller ports of Seahouses, Amble, Blyth and Hartlepool (Table 1).

TABLE 1 *British landings of* Nephrops (*cwt*)* *at the principal north-east coast ports and the total landings in England and Wales, 1926 to 1969*

| | North Shields | Hartlepool | Amble | Blyth | Seahouses (North Sunderland) | Sunderland | Total | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | North-east England | England and Wales |
| 1926 | 4 476 | 27 | – | – | – | 1 603 | 6 106 | 6 744 |
| 1927 | 6 102 | 110 | – | – | – | 3 883 | 10 095 | 11 672 |
| 1928 | 5 967 | 367 | – | – | – | 3 079 | 9 413 | 11 107 |
| 1929 | 6 267 | 148 | – | – | – | 3 175 | 9 590 | 10 965 |
| 1930 | 5 342 | 103 | – | – | – | 3 650 | 9 095 | 11 770 |
| 1931 | 4 689 | 103 | – | – | – | 3 116 | 7 908 | 10 126 |
| 1932 | 5 901 | 51 | – | – | – | 3 197 | 9 149 | 11 348 |
| 1933 | 4 460 | 8 | – | – | – | 2 326 | 6 794 | 9 721 |
| 1934 | 5 122 | 9 | – | – | – | 2 449 | 7 580 | 9 303 |
| 1935 | 5 192 | 20 | – | – | – | 2 025 | 7 237 | 9 465 |
| 1936 | 3 749 | – | – | – | – | 555 | 4 304 | 6 229 |
| 1937 | 1 821 | 45 | – | – | – | 106 | 1 972 | 3 001 |
| 1938 | 2 050 | 12 | – | – | – | 12 | 2 074 | 2 788 |
| 1939 | 1 792 | 87 | – | – | – | – | 1 879 | 2 547 |
| 1940 | 60 | 5 | – | – | – | – | 65 | 700 |
| } | NO RECORDS | | | | | | | |
| 1947 | 2 | – | – | – | – | – | 2 | 2 |
| 1948 | 45 | – | – | 5 | – | – | 50 | 322 |
| 1949 | 53 | – | – | – | – | – | 53 | 425 |
| 1950 | 401 | 6 | – | – | – | – | 407 | 1 553 |
| 1951 | 410 | – | – | – | – | – | 410 | 1 019 |
| 1952 | 241 | – | – | – | – | – | 241 | 744 |
| 1953 | 627 | – | – | – | – | – | 627 | 4 564 |
| 1954 | 475 | – | – | 1 | – | – | 476 | 4 958 |
| 1955 | 600 | – | – | – | – | – | 600 | 5 498 |
| 1956 | 332 | – | – | – | – | – | 332 | 4 317 |
| 1957 | 371 | – | – | – | – | – | 371 | 5 444 |
| 1958 | 186 | – | – | – | – | – | 186 | 7 779 |
| 1959 | 460 | 1 | – | – | – | – | 461 | 6 417 |
| 1960 | 5 007 | 31 | – | – | – | – | 5 038 | 8 487 |
| 1961 | 9 607 | 10 | – | – | – | – | 9 617 | 15 162 |
| 1962 | 3 187 | 3 | – | – | – | – | 3 190 | 6 395 |
| 1963 | 3 529 | – | – | – | – | – | 3 529 | 5 860 |
| 1964 | 4 170 | 20 | – | – | – | – | 4 190 | 7 034 |
| 1965 | 5 372 | – | 339 | 51 | – | – | 5 762 | 8 000 |
| 1966 | 9 878 | 424 | 3 379 | 1 029 | 1 583 | – | 16 293 | 20 938 |
| 1967 | 8 314 | 565 | 1 867 | 1 514 | 1 488 | – | 13 748 | 15 115 |
| 1968 | 9 571 | 692 | 3 522 | 2 354 | 1 460 | – | 17 599 | 19 361 |
| 1969 | 8 059 | 775 | 1 533 | 2 671 | 488 | – | 13 526 | 16 902 |

* Note: 1 cwt=approximately 51 kg




ig. 2 Annual landings of *Nephrops* by British vessels at north-east coast ports, other ports in England and Wales, and total ndings for England and Wales, 1895–1969.

From Figure 2 it can be seen that, apart from the 1950s, ne *Nephrops* fishery from north-east England has been the ost important in England and Wales since 1926. However, ne expansion of the north-east coast fishery after 1959 gged behind the rapid development in most of the Scottish sheries (Thomas 1965) and in the Irish Sea (O'Riordan 964), which had already started this upward swing in the arly 1950s.

Although reliable information on the landings of all ves-ls involved in the north-east coast fishery is available, that n effort cannot be obtained. However, monthly catch and ffort figures from selected trawlers under 80 feet (24 m) in ngth, landing at North Shields and known to be fishing for *lephrops* on the North Shields grounds during the period une 1962 to December 1969 inclusive, are available and are iven in Table 2 and Figure 3, together with the catch per nit effort. The landings by these *Nephrops* trawlers made p a high proportion of the total at North Shields. In eneral, the catches and effort were at their lowest during ne summer months and increased to a maximum during the utumn and winter. The catch per unit effort showed milar seasonal trends, being lowest in the summer and ighest in the winter, although the months of minimum and aximum catches per unit effort were not the same in each ear.

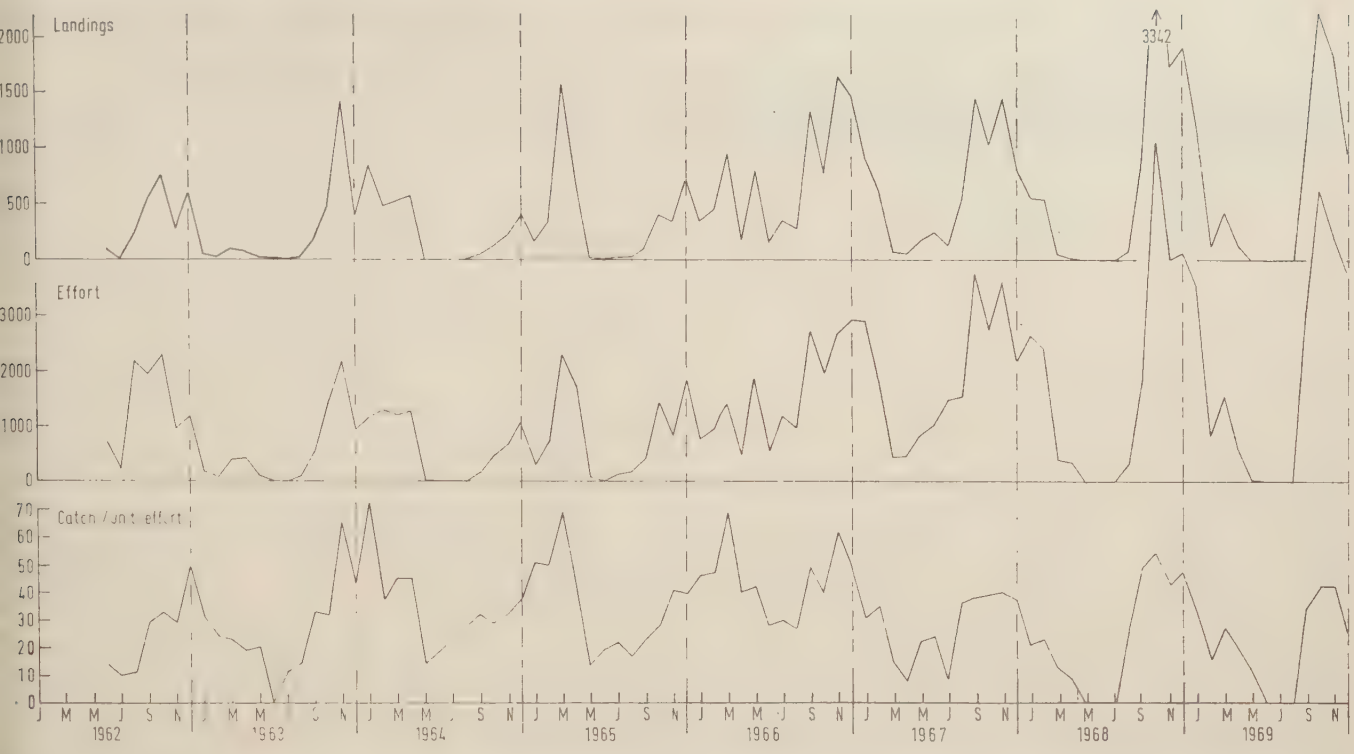
Monthly landings, effort and catch per unit effort for trawlers making one-day trips from North Shields in 1911 (data from Storrow 1912) are given in Figure 4. These show somewhat similar trends to the 1962–69 data, although the lowest effort was expended during the spring (February, March and April), increasing to a maximum in August. The catch per unit effort was similar to the more recent data, being highest from September to December inclusive.

The reasons for these seasonal changes in abundance are not known, but they may be due to changes in *Nephrops* behaviour making them less liable to capture by the fishing gear, or the decrease in catch per unit effort during the summer may be due to predation by the large numbers of cod present on the grounds during this season, followed by recruitment in the autumn. The changes in abundance are similar to those found in the Firth of Forth (Thomas 1969), although there the maximum landing and catch per unit effort normally occur earlier (August, September or October) than in the North Shields fishery.

The annual landings, effort and catch per unit effort of trawlers known to be fishing for *Nephrops* and landing at North Shields are shown in Figure 5 for 1963 to 1969, together with the total landings at north-east coast ports and the estimated total effort in terms of hours fishing by these

TABLE 2 *North Shields* Nephrops *landings, effort and catch per unit effort by trawlers under 80 feet (24 m) in length, known to be fishing for* Nephrops, *1962–69*

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual totals and mean c.p.e. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1962 | | | | | | | | | | | | | |
| Landings (cwt) | | | | | | 102 | 25 | 234 | 549 | 754 | 284 | 576 | 2 524 |
| Effort (hours fishing) | | NO DATA AVAILABLE | | | | 730 | 243 | 2 162 | 1 920 | 2 284 | 971 | 1 177 | 9 487 |
| Catch per unit effort (cwt/100 hours) | | | | | | 14.0 | 10.3 | 10.8 | 28.6 | 33.0 | 29.2 | 48.9 | 26.6 |
| 1963 | | | | | | | | | | | | | |
| Landings (cwt) | 60 | 22 | 94 | 81 | 22 | 0 | 1 | 14 | 182 | 474 | 1 418 | 403 | 2 771 |
| Effort (hours fishing) | 195 | 90 | 402 | 431 | 111 | 0 | 9 | 98 | 552 | 1 467 | 2 180 | 930 | 6 465 |
| Catch per unit effort (cwt/100 hours) | 30.8 | 24.4 | 23.4 | 18.8 | 19.8 | – | 11.1 | 14.3 | 33.0 | 32.3 | 65.0 | 43.3 | 42.9 |
| 1964 | | | | | | | | | | | | | |
| Landings (cwt) | 856 | 477 | 532 | 564 | 4 | 0 | 0 | 0 | 52 | 136 | 216 | 404 | 3 241 |
| Effort (hours fishing) | 1 183 | 1 297 | 1 179 | 1 266 | 28 | 0 | 0 | 0 | 162 | 468 | 675 | 1 051 | 7 309 |
| Catch per unit effort (cwt/100 hours) | 72.4 | 36.8 | 45.1 | 44.5 | 14.3 | – | – | – | 32.1 | 29.1 | 32.0 | 38.4 | 44.3 |
| 1965 | | | | | | | | | | | | | |
| Landings (cwt) | 160 | 353 | 1 566 | 707 | 15 | 5 | 30 | 31 | 96 | 402 | 344 | 728 | 4 437 |
| Effort (hours fishing) | 312 | 712 | 2 286 | 1 700 | 109 | 27 | 138 | 188 | 417 | 1 440 | 844 | 1 821 | 9 994 |
| Catch per unit effort (cwt/100 hours) | 51.3 | 49.6 | 68.5 | 41.6 | 13.8 | 18.5 | 21.7 | 16.5 | 23.0 | 27.9 | 40.8 | 40.0 | 44.4 |
| 1966 | | | | | | | | | | | | | |
| Landings (cwt) | 361 | 458 | 960 | 187 | 790 | 156 | 355 | 270 | 1 327 | 780 | 1 660 | 1 483 | 8 787 |
| Effort (hours fishing) | 780 | 978 | 1 399 | 468 | 1 874 | 560 | 1 175 | 995 | 2 708 | 1 948 | 2 683 | 2 922 | 18 490 |
| Catch per unit effort (cwt/100 hours) | 46.3 | 46.8 | 68.6 | 40.0 | 42.2 | 27.9 | 30.2 | 27.1 | 49.0 | 40.0 | 61.9 | 50.8 | 47.5 |
| 1967 | | | | | | | | | | | | | |
| Landings (cwt) | 892 | 625 | 68 | 39 | 181 | 241 | 136 | 550 | 1 440 | 1 067 | 1 459 | 802 | 7 500 |
| Effort (hours fishing) | 2 900 | 1 778 | 464 | 481 | 831 | 1 013 | 1 480 | 1 530 | 3 769 | 2 768 | 3 629 | 2 170 | 22 380 |
| Catch per unit effort (cwt/100 hours) | 30.8 | 35.2 | 14.7 | 8.1 | 21.8 | 23.8 | 9.2 | 35.9 | 38.2 | 38.5 | 40.2 | 37.0 | 33.5 |
| 1968 | | | | | | | | | | | | | |
| Landings (cwt) | 559 | 561 | 54 | 31 | 0 | 0 | 0 | 84 | 874 | 3 342 | 1 741 | 1 937 | 9 183 |
| Effort (hours fishing) | 2 639 | 2 394 | 417 | 340 | 9 | 0 | 0 | 321 | 1 790 | 6 138 | 4 013 | 4 134 | 22 195 |
| Catch per unit effort (cwt/100 hours) | 21.2 | 23.4 | 12.9 | 9.1 | – | – | – | 26.2 | 48.8 | 54.4 | 43.4 | 46.9 | 41.4 |
| 1969 | | | | | | | | | | | | | |
| Landings (cwt) | 1 153 | 137 | 420 | 121 | 2 | 0 | 0 | 0 | 1 054 | 2 254 | 1 855 | 978 | 7 974 |
| Effort (hours fishing) | 3 525 | 858 | 1 553 | 597 | 18 | 0 | 0 | 0 | 3 067 | 5 315 | 4 428 | 3 804 | 23 165 |
| Catch per unit effort | 32.7 | 16.0 | 27.0 | 20.3 | 11.1 | – | – | – | 34.4 | 42.4 | 41.9 | 25.7 | 34.4 |



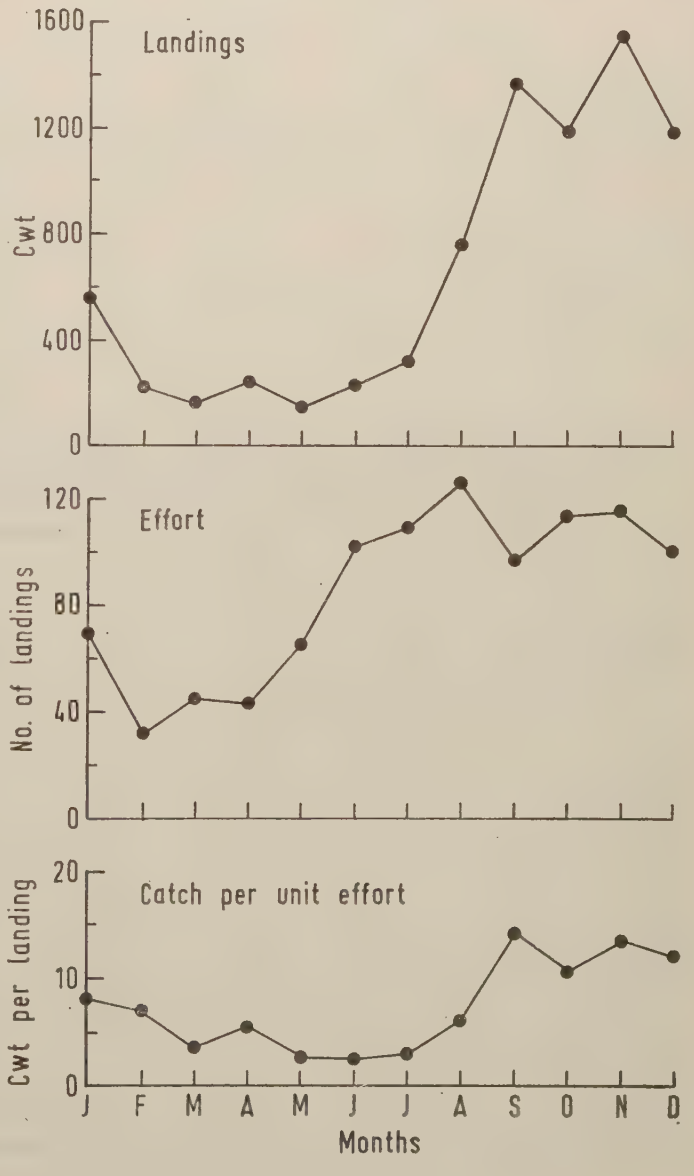

g. 3 Monthly *Nephrops* landings, effort and catch per unit effort of selected trawlers landing at North Shields, June 1962 to ecember 1969.

lected *Nephrops* trawlers from North Shields. Total land-gs increased four-fold from 3 500 cwt in 1963 to an average 15 000 cwt in 1967–69, while the effort increased by 5 mes from 8 200 hours in 1963 to over 41 000 hours in 967–69. During this same period the catch per unit effort adually decreased from 43 cwt per 100 hours' fishing in 963 to 34 cwt per 100 hours' fishing in 1969.

*y-catch*

The landings of *Nephrops* and total by-catch, together ith the catch per unit effort of the different species, taken *Nephrops* trawlers landing at North Shields are given nually for 1962 to 1969 inclusive in Table 3 and monthly r 1969 in Table 4. The annual landings of by-catch ex-eded those of *Nephrops*, the main species being cod and hiting and, to a lesser extent, haddock. The deep-water rawn, *Pandalus borealis* Krøyer, formed a very small pro-ortion of the by-catch, even though it is known to occur large quantities on the same grounds in some years, for ample in 1967 (Warren, pers. comm.).

Each monthly landing of by-catch in 1969 was also greater an that of *Nephrops* (Table 4). Bearing in mind that no ndings were made by *Nephrops* trawlers at North Shields ring June, July and August, the catch per unit effort of d was relatively high in April and May, whereas that for hiting was best in January, February and December. The ndings of haddock in 1969 were good, and catch rates ere high in all months except March and April. The other corded species showed relatively low catch rates through-t the year, although plaice gave a maximum value in arch and lemon sole in May.




g. 4 (*right*) Monthly *Nephrops* landings, effort and catch r unit effort of trawlers landing at North Shields in 1911 ata from Storrow 1912).

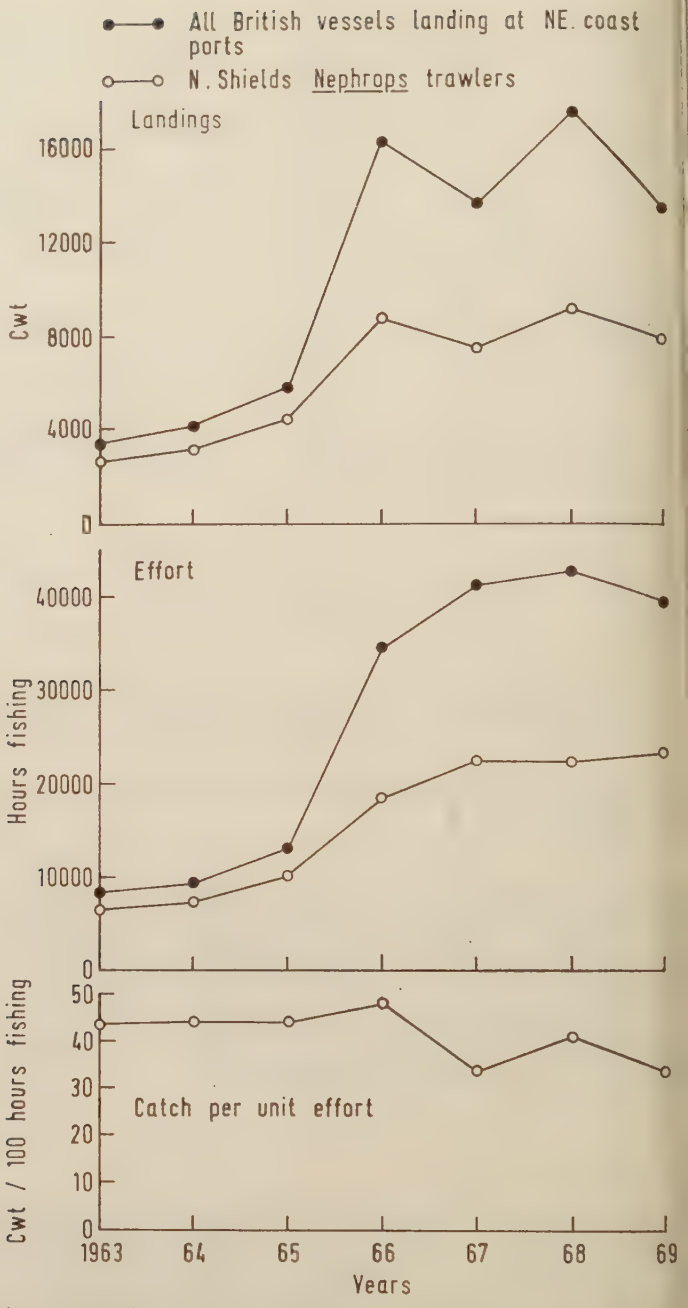



Fig. 5 Annual *Nephrops* landings, effort and catch per unit effort of selected trawlers landing at North Shields, and landings and estimated effort of all British vessels landing at north-east coast ports, 1963–69.

TABLE 3 *Annual landings of* Nephrops *and by-catch by* Nephrops *trawlers at North Shields, 1962–69, together with the catch per unit effort of the main by-catch species* (+ = *less than 0.05 cwt per 100 hours fishing*)

| | 1962* | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|---|---|---|
| | Annual landings (cwt) | | | | | | | |
| *Nephrops* | 2 524 | 2 771 | 3 241 | 4 437 | 8 787 | 7 500 | 9 183 | 7 974 |
| By-catch | 5 491 | 6 021 | 6 844 | 8 621 | 10 893 | 10 678 | 11 380 | 15 706 |
| | Catch per unit of effort of by-catch species (cwt/100 hours fishing) | | | | | | | |
| Cod | 20.7 | 9.8 | 10.6 | 17.0 | 16.9 | 12.7 | 10.4 | 9.2 |
| Dogfish | 0.7 | 2.7 | 2.2 | 1.1 | 3.1 | 1.6 | 5.2 | 3.7 |
| Haddock | 0.6 | 7.0 | 11.0 | 2.3 | 1.9 | 0.5 | 1.0 | 25.2 |
| Lemon sole | 0.1 | 0.1 | 1.0 | 2.8 | 2.4 | 2.4 | 2.3 | 1.4 |
| Plaice | 2.3 | 5.5 | 9.3 | 6.3 | 6.9 | 6.0 | 6.5 | 5.3 |
| Skates/rays | 4.6 | 4.9 | 6.0 | 3.6 | 1.8 | 1.4 | 1.5 | 1.3 |
| Whiting | 20.3 | 46.4 | 32.7 | 39.5 | 14.2 | 9.7 | 12.7 | 11.2 |
| Unspecified | 8.6 | 16.8 | 20.9 | 13.4 | 11.1 | 11.4 | 11.1 | 10.4 |
| Total pelagic | 0.1 | + | 0.1 | 0.3 | 0.5 | 1.2 | 0.1 | + |
| *Pandalus borealis* | – | – | – | – | – | 0.9 | 0.6 | + |
| Total by-catch | 58.0 | 93.2 | 93.8 | 86.3 | 58.8 | 47.8 | 51.4 | 67.7 |

* June–December only

ABLE 4 *Monthly landings of* Nephrops *and by-catch by* Nephrops *trawlers at North Shields in 1969, together with the catch per unit effort of the main by-catch species.*
*(N.B. No landings were made in June, July and August; + = less than 0.05 cwt per 100 hours fishing)*

| | Jan | Feb | Mar | Apr | May | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|
| | Monthly landings (cwt) | | | | | | | | |
| *phrops* | 1 153 | 137 | 420 | 121 | 2 | 1 054 | 2 254 | 1 855 | 978 |
| -catch | 3 059 | 585 | 1 029 | 518 | 20 | 2 072 | 3 536 | 1 861 | 3 027 |
| | Catch per unit effort of by-catch species (cwt/100 hours fishing) | | | | | | | | |
| od | 22.2 | 7.0 | 9.3 | 53.1 | 55.6 | 6.3 | 2.9 | 0.9 | 11.3 |
| gfish | – | – | – | – | – | 4.1 | 12.7 | 0.1 | 1.2 |
| addock | 21.0 | 17.6 | 11.5 | 5.0 | 22.2 | 32.0 | 27.3 | 21.9 | 35.3 |
| mon sole | 2.2 | 5.2 | 7.6 | 7.9 | 11.1 | 0.4 | 0.4 | – | 0.3 |
| aice | 8.8 | 12.7 | 14.8 | 5.9 | 5.6 | 3.4 | 3.1 | 0.9 | 6.4 |
| ates/rays | 4.6 | 2.3 | 2.6 | 3.7 | – | 0.1 | 0.3 | 0.2 | 0.6 |
| hiting | 18.1 | 16.1 | 11.1 | – | – | 10.0 | 8.1 | 9.0 | 13.4 |
| nspecified | 10.0 | 6.6 | 9.4 | 11.2 | 16.7 | 11.2 | 11.5 | 9.1 | 11.1 |
| otal pelagic | – | – | – | – | – | + | 0.2 | – | – |
| *ndalus borealis* | – | 0.6 | – | – | – | – | – | – | – |
| otal by-catch | 86.9 | 68.1 | 66.3 | 86.8 | 111.2 | 67.5 | 66.5 | 42.1 | 79.6 |

TABLE 5 *North Shields* Nephrops; *carapace length compositions and mean values of each haul made by* RV TELLINA, *Cruise 8(b), October 1969*

| Haul | Sex | Carapace length (5 mm groups) | | | | | | | | | | | | Total number | Mean length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | |
| 1 | Male | 95 | 438 | 277 | 116 | 60 | 7 | 7 | – | – | – | – | – | 1 000 | 28.8 |
| | Female | 102 | 350 | 126 | 88 | 28 | – | 7 | – | – | – | – | – | 701 | 27.8 |
| 2 | Male | 14 | 256 | 277 | 126 | 53 | – | 7 | – | – | – | – | – | 733 | 30.3 |
| | Female | 46 | 256 | 172 | 84 | 28 | 7 | – | – | – | – | – | – | 593 | 28.9 |
| 3 | Male | 24 | 114 | 124 | 38 | 20 | 10 | 10 | 10 | – | 4 | – | – | 354 | 31.4 |
| | Female | 24 | 144 | 74 | 26 | 16 | 4 | 4 | – | – | – | – | – | 292 | 28.7 |
| 4 | Male | 30 | 219 | 297 | 132 | 36 | 12 | 12 | 18 | 6 | – | – | – | 762 | 31.4 |
| | Female | 48 | 285 | 195 | 96 | 72 | 6 | 6 | – | – | – | – | – | 708 | 29.8 |
| 5 | Male | 18 | 146 | 160 | 86 | 42 | 8 | – | – | 4 | – | – | – | 464 | 30.9 |
| | Female | 30 | 190 | 150 | 64 | 26 | 18 | 8 | – | – | – | – | – | 486 | 30.0 |
| 6 | Male | 3 | 14 | 46 | 27 | 16 | 12 | – | – | – | 2 | 1 | – | 121 | 34.5 |
| | Female | 5 | 21 | 32 | 28 | 14 | 6 | 3 | 1 | – | 1 | – | – | 111 | 33.5 |
| 7 | Male | 5 | 45 | 60 | 26 | 26 | 9 | 11 | 12 | 8 | 2 | – | – | 204 | 35.8 |
| | Female | 2 | 39 | 23 | 18 | 12 | 9 | 5 | – | – | – | – | – | 108 | 32.6 |
| 9 | Male | 1 | 4 | 7 | 10 | 8 | – | 4 | 5 | 5 | 1 | – | – | 45 | 41.4 |
| | Female | 1 | 4 | 5 | 4 | 6 | 2 | 1 | – | – | – | – | – | 23 | 34.8 |
| 10 | Male | – | – | 1 | – | – | – | 1 | 1 | 2 | 1 | – | – | 6 | 53.8 |
| | Female | – | – | – | – | – | – | – | – | – | – | – | – | 0 | – |
| 11 | Male | – | – | 1 | 1 | – | – | 1 | – | 1 | – | – | – | 4 | 44.3 |
| | Female | – | – | 1 | 1 | – | – | – | – | – | – | – | – | 2 | 33.0 |
| 12 | Male | 6 | 5 | 10 | 17 | 12 | – | 3 | – | 2 | 2 | 1 | – | 58 | 36.5 |
| | Female | 3 | 11 | 15 | 6 | 5 | 2 | 3 | – | – | – | – | – | 45 | 32.4 |
| 13 | Male | 12 | 60 | 124 | 54 | 24 | – | 4 | 4 | 2 | 4 | – | – | 288 | 32.1 |
| | Female | 26 | 112 | 94 | 48 | 38 | 10 | 4 | 2 | – | – | – | – | 334 | 30.7 |
| 14 | Male | 5 | 9 | 22 | 16 | 6 | 5 | 5 | 3 | 1 | 1 | – | – | 73 | 35.4 |
| | Female | 5 | 18 | 18 | 19 | 6 | 7 | 1 | – | – | – | – | – | 74 | 32.4 |
| 15 | Male | 1 | 1 | 4 | 6 | 5 | 2 | – | – | – | – | – | – | 19 | 35.5 |
| | Female | – | 2 | 5 | 1 | 1 | – | – | – | – | – | – | – | 9 | 31.1 |
| 16 | Male | 24 | 56 | 94 | 13 | 7 | 13 | 9 | 2 | – | – | – | – | 218 | 30.7 |
| | Female | 17 | 92 | 41 | 9 | 4 | 4 | – | 2 | – | – | – | – | 169 | 27.9 |
| 17 | Male | 4 | 64 | 98 | 72 | 26 | 20 | 4 | 4 | – | – | – | – | 292 | 33.0 |
| | Female | 24 | 100 | 74 | 52 | 20 | 6 | 4 | – | – | – | – | – | 280 | 30.1 |
| 18 | Male | 1 | 10 | 23 | 17 | 11 | 11 | 8 | 15 | 8 | 5 | 1 | – | 110 | 42.2 |
| | Female | 4 | 11 | 21 | 11 | 23 | 7 | 10 | 5 | – | – | – | – | 92 | 37.2 |
| 19 | Male | 2 | 2 | 11 | 12 | 24 | 12 | 6 | 5 | 3 | 2 | – | – | 79 | 41.3 |
| | Female | 1 | 1 | 6 | 1 | 8 | 10 | 15 | 5 | 1 | – | – | – | 48 | 44.6 |
| 20 | Male | 10 | 23 | 39 | 41 | 33 | 8 | 4 | – | 2 | 2 | 1 | 1 | 164 | 35.0 |
| | Female | 15 | 21 | 28 | 26 | 18 | 5 | 5 | – | – | – | – | – | 118 | 32.4 |
| 21 | Male | – | – | 1 | – | – | – | – | – | – | – | 1 | – | 2 | 50.5 |
| | Female | – | – | – | – | – | – | – | – | – | – | – | – | 0 | – |
| 22 | Male | 4 | 21 | 59 | 46 | 23 | 3 | 1 | – | – | – | – | – | 157 | 32.9 |
| | Female | 1 | 22 | 35 | 17 | 22 | 11 | – | – | – | – | – | – | 108 | 33.7 |
| 23 | Male | 10 | 78 | 95 | 58 | 8 | 15 | 10 | 5 | 5 | 3 | – | – | 287 | 32.9 |
| | Female | 20 | 88 | 55 | 28 | 38 | 3 | 10 | – | – | – | – | – | 242 | 31.0 |
| 25 | Male | – | 1 | – | – | – | 1 | 1 | 1 | 1 | – | – | – | 5 | 47.5 |
| | Female | – | – | – | – | – | – | – | – | – | – | – | – | 0 | – |
| 26 | Male | – | – | – | 1 | – | – | – | 1 | – | – | – | – | 2 | 45.5 |
| | Female | – | – | – | – | – | – | 1 | – | – | – | – | – | 1 | 50.5 |
| 27 | Male | 68 | 168 | 130 | 20 | 20 | 8 | – | – | – | – | – | – | 414 | 27.8 |
| | Female | 46 | 152 | 106 | 84 | 16 | 8 | – | – | – | – | – | – | 412 | 29.2 |
| 30 | Male | – | – | 1 | – | – | – | – | – | – | – | – | – | 1 | 30.5 |
| | Female | – | – | 1 | 1 | – | – | – | – | – | – | – | – | 2 | 33.0 |

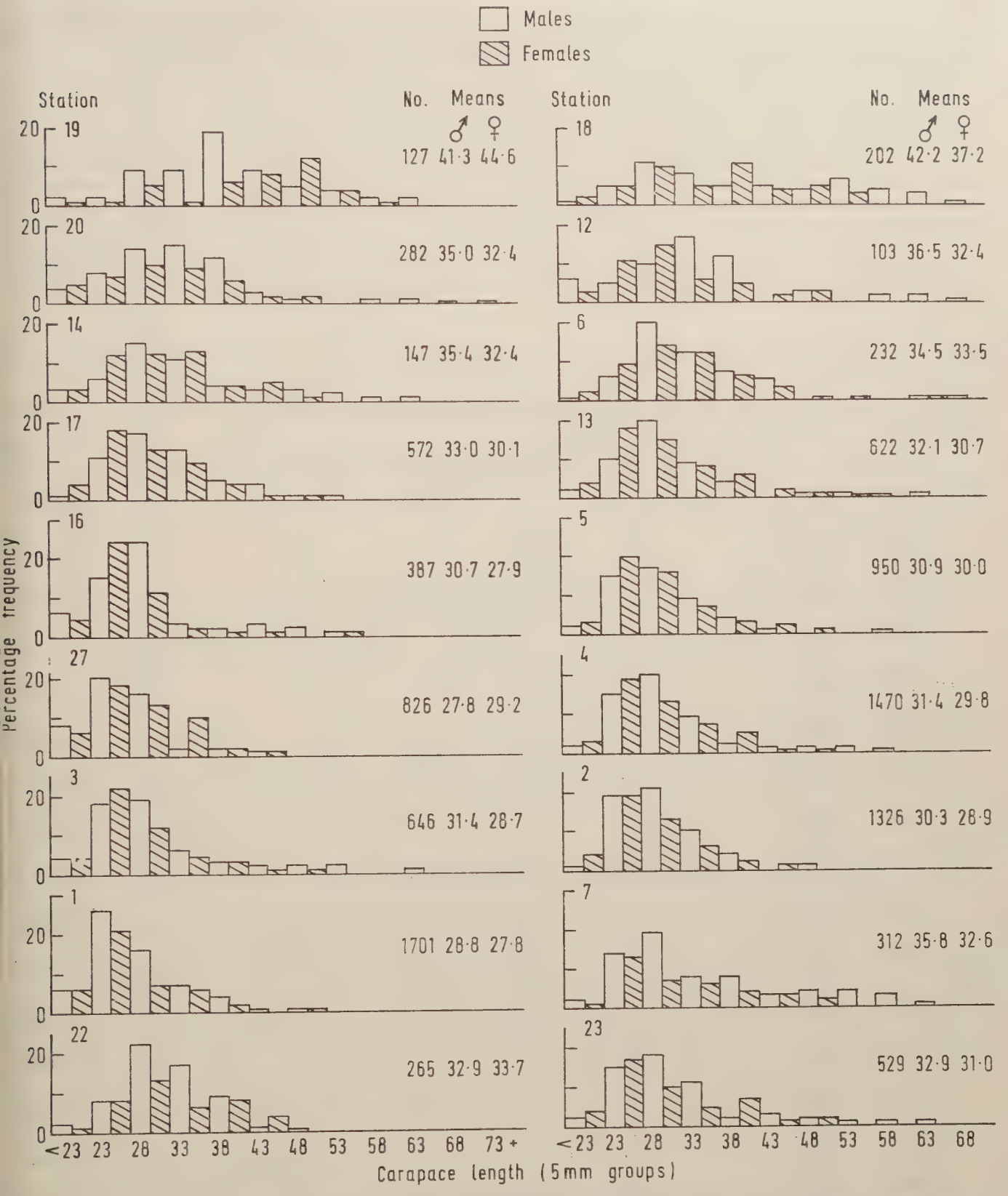



Fig. 6 Percentage carapace length compositions of male and female *Nephrops* in each haul made from RV TELLINA, October 1969.

## LENGTH COMPOSITIONS

As recommended at the Special Meeting of the *Conseil International pour l'Exploration de la Mer* held in 1962 to consider problems in the exploitation and regulation of crustacean fisheries, the carapace length has been adopted as the standard measure for *Nephrops*. These measurements have been made to the millimetre below and have been grouped into 5 mm size intervals (i.e. 23–27 mm, 28–32 mm, etc.).

The length compositions of *Nephrops* from different parts of the ground were investigated by measuring the *Nephrops* from individual ½ hour hauls made from the TELLINA in October 1969 (see Figure 1B). The length compositions of male and female *Nephrops* caught in each haul are given in Table 5 and the percentage length compositions of hauls containing 100 or more *Nephrops* are shown in Figure 6.

Differences in length compositions of both males and females on different parts of the ground were not large, although there was a tendency for the proportion of larger *Nephrops* of both sexes to be higher in the northerly and, to a certain extent, the most southerly hauls. The absence of larger *Nephrops* at stations adjacent to the R. Tyne is possibly the result of the intensive fishing in this area by boats from North Shields. Simpson (1965) found that on several grounds, including North Shields, although there was a slightly lower proportion of small *Nephrops* (under 25 mm carapace length) in the daylight hauls compared with those taken in total darkness, the size composition did not vary greatly between the catches over 24-hour periods; therefore, the slight differences found in these investigations in the size compositions of *Nephrops* from the different parts of the ground were unlikely to have been caused by the hauls being made at different times of the day.

From 1962 to 1968, routine carapace length measurements have been made on the laboratory samples and on market samples from boats landing at North Shields. The length compositions and mean values of male and female *Nephrops* in both types of sample, together with other relevant information on the market samples, are given in Tables 6 and 7 respectively. Samples were not obtained in every month, but comparisons between the percentage length compositions of the laboratory and market samples are possible in 25 months over the period and these are given in Table 8.

TABLE 6 *North Shields* Nephrops; *carapace length distributions and mean values of each monthly laboratory sample, 1962–68*

| Year | Month | Sex | Carapace length (5 mm groups) | | | | | | | | | | | Total number | Mean length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | |
| 1962 | August | Male | 1 | 8 | 26 | 29 | 25 | 38 | 24 | 28 | 14 | 8 | 6 | 1 | 208 | 45.3 |
| | | Female | – | 16 | 20 | 29 | 39 | 10 | 2 | – | – | – | – | – | 116 | 36.1 |
| | September | Male | 2 | 7 | 18 | 14 | 17 | 21 | 33 | 27 | 27 | 16 | 3 | – | 185 | 48.5 |
| | | Female | – | 7 | 15 | 13 | 21 | 7 | 2 | – | – | – | – | – | 65 | 36.4 |
| | October | Male | 1 | 31 | 49 | 30 | 11 | 21 | 20 | 24 | 13 | 3 | – | – | 203 | 39.9 |
| | | Female | 2 | 25 | 41 | 67 | 91 | 37 | 6 | – | – | – | – | – | 269 | 37.1 |
| | November | Male | 13 | 71 | 188 | 93 | 26 | 13 | 5 | 2 | 4 | 5 | 1 | – | 421 | 32.7 |
| | | Female | 31 | 85 | 83 | 25 | 54 | 38 | 11 | 2 | – | – | – | – | 329 | 32.8 |
| | December | Male | – | 50 | 82 | 24 | 15 | 7 | 6 | 3 | 2 | – | – | – | 189 | 32.5 |
| | | Female | – | 36 | 40 | 66 | 139 | 82 | 11 | – | – | – | – | – | 374 | 38.5 |
| 1963 | January | Male | 1 | 48 | 73 | 45 | 28 | 19 | 11 | 6 | – | – | – | 1 | 232 | 34.6 |
| | | Female | 1 | 23 | 53 | 45 | 96 | 81 | 16 | 1 | – | – | – | – | 316 | 38.8 |
| | April | Male | 3 | 17 | 92 | 58 | 45 | 25 | 14 | 8 | 6 | 2 | – | – | 270 | 36.9 |
| | | Female | – | 16 | 68 | 41 | 86 | 36 | 7 | – | – | – | – | – | 254 | 37.1 |
| | August | Male | – | 2 | 13 | 30 | 28 | 30 | 29 | 28 | 16 | 4 | 3 | – | 183 | 46.3 |
| | | Female | – | 1 | 6 | 5 | 3 | 3 | 3 | 1 | – | – | – | – | 22 | 38.7 |
| | October | Male | 7 | 14 | 64 | 56 | 42 | 36 | 22 | 14 | 15 | 15 | 4 | – | 289 | 41.0 |
| | | Female | 4 | 17 | 49 | 10 | 25 | 20 | 4 | – | – | – | – | – | 129 | 34.8 |
| | November | Male | 1 | 34 | 81 | 159 | 72 | 20 | 9 | 6 | 2 | – | 1 | – | 385 | 35.9 |
| | | Female | – | 24 | 63 | 46 | 36 | 32 | 3 | – | 1 | – | – | – | 205 | 35.6 |
| | December | Male | – | 2 | 6 | 11 | 33 | 34 | 21 | 14 | 8 | 2 | 2 | – | 133 | 45.9 |
| | | Female | 1 | 2 | 3 | 5 | 80 | 52 | 22 | 1 | 1 | – | – | – | 167 | 43.0 |
| 1964 | January | Male | 1 | 59 | 133 | 84 | 45 | 19 | 3 | 5 | 2 | – | – | – | 351 | 33.6 |
| | | Female | – | 71 | 68 | 21 | 20 | 11 | – | – | – | – | – | – | 191 | 31.1 |
| | February | Male | 3 | 28 | 70 | 160 | 47 | 40 | 24 | 2 | 2 | 1 | – | – | 377 | 36.7 |
| | | Female | – | 21 | 43 | 26 | 22 | 23 | 5 | – | – | – | – | – | 140 | 35.4 |
| | March | Male | 1 | 26 | 105 | 117 | 65 | 33 | 14 | 5 | 3 | – | 1 | – | 370 | 36.2 |
| | | Female | – | 32 | 72 | 41 | 24 | 19 | 6 | 1 | – | – | – | – | 195 | 34.2 |
| | April | Male | – | 3 | 26 | 30 | 43 | 27 | 22 | 23 | 16 | 6 | 1 | – | 197 | 44.3 |
| | | Female | – | 2 | 19 | 14 | 6 | 14 | 12 | 5 | – | – | – | – | 72 | 40.2 |
| | May | Male | – | 2 | 24 | 51 | 62 | 50 | 32 | 16 | 12 | 3 | 4 | – | 256 | 43.3 |
| | | Female | – | 6 | 23 | 16 | 18 | 22 | 7 | 1 | – | – | – | – | 93 | 38.3 |
| | June | Male | – | 5 | 25 | 56 | 73 | 80 | 50 | 16 | 10 | 9 | 4 | 1 | 329 | 43.9 |
| | | Female | 1 | 14 | 25 | 11 | 13 | 9 | 4 | 1 | – | – | – | – | 78 | 34.9 |
| | August | Male | – | – | 7 | 24 | 19 | 24 | 17 | 19 | 23 | 13 | 7 | – | 153 | 49.5 |
| | | Female | – | – | – | 1 | 1 | 6 | 1 | – | – | – | – | – | 9 | 44.4 |
| | October | Male | – | 25 | 42 | 53 | 31 | 27 | 30 | 14 | 9 | 1 | – | – | 232 | 39.6 |
| | | Female | 2 | 31 | 27 | 30 | 32 | 36 | 19 | 5 | – | – | – | – | 182 | 37.9 |
| | November | Male | 4 | 37 | 153 | 135 | 78 | 23 | 9 | 2 | 1 | 1 | 1 | – | 444 | 34.8 |
| | | Female | 6 | 33 | 40 | 16 | 20 | 18 | 2 | – | – | – | – | – | 135 | 33.2 |
| | December | Male | 1 | 8 | 81 | 113 | 79 | 49 | 12 | 3 | 2 | 1 | – | – | 349 | 37.5 |
| | | Female | 1 | 9 | 47 | 17 | 44 | 24 | 6 | – | – | – | – | – | 148 | 36.9 |

E 6—*continued*

| Month | Sex | Carapace length (5 mm groups) | | | | | | | | | | | | Total number | Mean length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | |
| January | Male | – | – | 4 | 14 | 57 | 58 | 60 | 28 | 1 | 1 | – | – | 223 | 46.1 |
| | Female | – | – | 1 | 2 | 6 | 4 | 3 | 2 | – | – | – | – | 18 | 43.8 |
| February | Male | – | – | 10 | 22 | 46 | 34 | 33 | 9 | 11 | 4 | 1 | – | 170 | 45.1 |
| | Female | – | – | 12 | 8 | 8 | 16 | 32 | 4 | – | – | – | – | 80 | 44.3 |
| March | Male | – | – | 13 | 23 | 87 | 49 | 18 | 6 | 5 | 2 | 2 | – | 205 | 42.8 |
| | Female | – | 2 | 15 | 5 | 4 | 10 | 3 | – | – | – | – | – | 39 | 37.3 |
| April | Male | – | 10 | 98 | 138 | 73 | 36 | 10 | 3 | 1 | – | – | – | 369 | 36.5 |
| | Female | 1 | 7 | 65 | 5 | 10 | 7 | – | – | – | – | – | – | 95 | 32.4 |
| August | Male | – | 12 | 62 | 103 | 92 | 69 | 33 | 16 | 12 | 8 | 3 | – | 410 | 40.8 |
| | Female | – | 2 | 29 | 24 | 2 | 3 | 1 | – | – | – | – | – | 61 | 33.7 |
| September | Male | – | 3 | 28 | 53 | 65 | 64 | 36 | 19 | 17 | 7 | 1 | – | 293 | 43.6 |
| | Female | – | 6 | 30 | 12 | 1 | 3 | 2 | – | – | – | – | – | 54 | 32.8 |
| October | Male | – | 13 | 56 | 85 | 84 | 78 | 39 | 14 | 13 | 5 | – | – | 387 | 41.0 |
| | Female | – | 25 | 67 | 53 | 15 | 15 | 12 | 1 | – | – | – | – | 188 | 34.6 |
| November | Male | – | 2 | 17 | 24 | 43 | 51 | 44 | 11 | 2 | – | – | – | 194 | 43.5 |
| | Female | – | 1 | 11 | 32 | 19 | 38 | 19 | 2 | – | – | – | – | 122 | 41.5 |
| December | Male | – | 7 | 39 | 96 | 108 | 78 | 34 | 5 | 2 | 2 | 1 | 1 | 373 | 40.5 |
| | Female | – | 10 | 6 | 16 | 12 | 22 | 1 | – | – | – | – | – | 67 | 38.0 |
| January | Male | – | – | 3 | 14 | 60 | 89 | 84 | 46 | 16 | 5 | – | – | 317 | 47.8 |
| | Female | – | – | – | 3 | 4 | 6 | 1 | – | – | – | – | – | 14 | 42.3 |
| March | Male | 6 | 26 | 185 | 201 | 173 | 106 | 53 | 13 | 3 | 1 | – | – | 767 | 37.9 |
| | Female | 3 | 29 | 136 | 140 | 25 | 20 | 5 | – | – | – | – | – | 358 | 33.8 |
| April | Male | – | – | 12 | 35 | 58 | 79 | 65 | 19 | 7 | 1 | – | – | 276 | 44.8 |
| | Female | – | – | 25 | 14 | 3 | 2 | – | – | – | – | – | – | 44 | 33.5 |
| May | Male | 1 | 6 | 21 | 43 | 89 | 61 | 38 | 13 | 2 | 1 | 1 | – | 276 | 42.1 |
| | Female | – | – | 32 | 52 | 17 | 25 | 5 | 2 | – | – | – | – | 133 | 37.7 |
| July | Male | – | 1 | 8 | 37 | 59 | 73 | 55 | 28 | 4 | 4 | 1 | – | 270 | 45.2 |
| | Female | – | – | 6 | 12 | 5 | 5 | 1 | – | – | – | – | – | 29 | 37.6 |
| October | Male | 5 | 37 | 40 | 34 | 49 | 37 | 35 | 3 | 2 | 2 | – | 1 | 245 | 38.4 |
| | Female | 12 | 26 | 96 | 193 | 52 | 41 | 10 | 1 | – | – | – | – | 431 | 35.3 |
| November | Male | – | 7 | 18 | 57 | 90 | 89 | 48 | 8 | 1 | – | – | – | 318 | 42.1 |
| | Female | 1 | 8 | 12 | 43 | 44 | 27 | 8 | – | – | – | – | – | 143 | 38.7 |
| February | Male | 3 | 31 | 149 | 155 | 107 | 120 | 80 | 40 | 13 | 2 | 1 | – | 701 | 39.9 |
| | Female | – | 30 | 53 | 52 | 37 | 25 | 11 | 1 | – | – | – | – | 209 | 35.8 |
| April | Male | – | – | 7 | 16 | 44 | 44 | 50 | 32 | 17 | 2 | 2 | – | 214 | 47.5 |
| | Female | – | – | 6 | 15 | 4 | 2 | 1 | – | – | – | – | – | 28 | 36.4 |
| June | Male | – | 2 | 9 | 8 | 15 | 29 | 51 | 44 | 35 | 14 | 7 | – | 214 | 51.8 |
| | Female | – | – | 6 | 5 | 1 | 1 | – | – | – | – | – | – | 13 | 34.3 |
| July | Male | – | 1 | 2 | 13 | 27 | 38 | 48 | 50 | 22 | 8 | 4 | 1 | 214 | 50.4 |
| | Female | – | 1 | – | 3 | 1 | 1 | – | – | – | – | – | – | 6 | 36.3 |
| September | Male | 2 | 3 | 13 | 14 | 48 | 64 | 52 | 35 | 8 | 1 | – | – | 240 | 45.8 |
| | Female | 2 | 3 | 10 | 7 | 4 | 4 | 2 | – | – | – | – | – | 32 | 34.9 |
| October | Male | 11 | 76 | 214 | 94 | 45 | 29 | 18 | 7 | – | 1 | – | – | 495 | 33.4 |
| | Female | 14 | 66 | 115 | 70 | 36 | 20 | 3 | – | – | – | – | – | 324 | 32.4 |
| November | Male | 24 | 123 | 207 | 126 | 19 | 19 | 9 | 3 | 1 | – | – | – | 531 | 31.5 |
| | Female | 29 | 89 | 103 | 44 | 17 | 8 | 1 | 1 | – | – | – | – | 292 | 29.9 |
| January | Male | 1 | 13 | 127 | 134 | 25 | 18 | 26 | 12 | 4 | – | – | – | 360 | 36.2 |
| | Female | – | 4 | 38 | 63 | 23 | 15 | 7 | 2 | – | – | – | – | 152 | 36.7 |
| February | Male | 7 | 59 | 121 | 43 | 32 | 33 | 16 | 15 | 4 | – | – | – | 330 | 35.0 |
| | Female | 22 | 48 | 87 | 35 | 15 | 4 | 1 | – | – | – | – | – | 212 | 30.2 |
| March | Male | – | 4 | 20 | 31 | 33 | 51 | 33 | 14 | 6 | 5 | – | – | 197 | 43.7 |
| | Female | – | 1 | 8 | 7 | 5 | 3 | – | 1 | – | – | – | – | 25 | 36.5 |
| April | Male | 4 | 63 | 121 | 85 | 15 | 8 | 16 | 6 | 8 | 5 | – | – | 331 | 34.2 |
| | Female | 7 | 39 | 155 | 39 | 4 | 2 | 1 | – | – | – | – | – | 247 | 30.6 |

TABLE 7 *North Shields* Nephrops; *carapace length distributions, mean values and other relevant information of the monthly market samples, 1962–67*

| Year | Month | Sex | Carapace length distribution of catch of sampled boats (5 mm groups) | | | | | | | | | | | | Total | Mean length (mm) | Landings (cwt) | | Effort (hours) all boats | Number of *Nephrops* measured |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | | sampled boats | all boats | | |
| 1962 | June | Male | 9 | 328 | 478 | 502 | 502 | 447 | 495 | 430 | 225 | 130 | 13 | – | 3 559 | 43.1 | 4.69 | 102 | 730 | 1 881 |
| | | Female | 19 | 400 | 337 | 168 | 201 | 104 | 15 | – | – | – | – | – | 1 244 | 32.5 | | | | |
| | July | Male | 26 | 114 | 408 | 230 | 446 | 392 | 535 | 422 | 265 | 102 | 29 | 11 | 2 980 | 45.6 | 3.97 | 25 | 243 | 472 |
| | | Female | 26 | 150 | 197 | 202 | 154 | 72 | 16 | – | – | – | – | – | 817 | 34.1 | | | | |
| | August | Male | – | 4 | 45 | 82 | 126 | 327 | 282 | 323 | 113 | 67 | 29 | – | 1 398 | 49.9 | 2.63 | 234 | 2 162 | 381 |
| | | Female | – | 4 | 25 | 82 | 69 | 66 | 32 | – | 1 | – | – | – | 279 | 40.3 | | | | |
| | September | Male | – | – | 23 | 109 | 305 | 1 081 | 1 092 | 665 | 196 | 272 | 23 | – | 3 766 | 50.3 | 7.69 | 549 | 1 920 | 190 |
| | | Female | – | – | 69 | 138 | 737 | 552 | 378 | 23 | – | – | – | – | 1 897 | 43.4 | | | | |
| | October | Male | 136 | 524 | 1 225 | 1 490 | 1 066 | 1 210 | 871 | 460 | 309 | 60 | 91 | – | 7 442 | 40.7 | 9.56 | 754 | 2 284 | 340 |
| | | Female | 68 | 135 | 406 | 1 475 | 3 012 | 1 618 | 310 | – | – | – | – | – | 7 024 | 40.0 | | | | |
| | November | Male | 15 | 16 | 272 | 306 | 277 | 176 | 123 | 141 | 79 | 58 | 45 | – | 1 508 | 43.0 | 2.00 | 284 | 971 | 244 |
| | | Female | – | 31 | 113 | 266 | 490 | 357 | 23 | 15 | – | – | – | – | 1 295 | 40.0 | | | | |
| | December | Male | – | 15 | 61 | 114 | 182 | 159 | 46 | 23 | 31 | 8 | – | – | 639 | 42.1 | 0.63 | 576 | 1 177 | 110 |
| | | Female | – | – | 24 | 16 | 69 | 85 | 8 | – | – | – | – | – | 202 | 41.4 | | | | |
| 1963 | January | Male | – | 705 | 1 018 | 1 320 | 1 313 | 1 254 | 697 | 609 | 202 | 167 | 13 | 1 | 7 299 | 41.0 | 13.13 | 60 | 195 | 611 |
| | | Female | – | 284 | 817 | 1 668 | 3 167 | 3 867 | 976 | 90 | 1 | – | – | – | 10 870 | 41.4 | | | | |
| | February | Male | – | 37 | 147 | 92 | 166 | 147 | 129 | 55 | 37 | 18 | – | 18 | 846 | 43.1 | 2.50 | 22 | 90 | 169 |
| | | Female | – | 92 | 239 | 221 | 810 | 737 | 166 | – | – | – | – | – | 2 265 | 40.7 | | | | |
| | April | Male | – | 138 | 275 | 303 | 165 | 220 | 138 | 55 | – | 28 | – | – | 1 322 | 38.7 | 2.81 | 40 | 211 | 172 |
| | | Female | – | 358 | 605 | 468 | 908 | 743 | 303 | 28 | – | – | – | – | 3 413 | 38.6 | | | | |
| | August | Male | – | 10 | 10 | 68 | 114 | 84 | 95 | 54 | 40 | 36 | 12 | – | 523 | 47.5 | 0.69 | 14 | 98 | 151 |
| | | Female | – | – | 20 | 21 | – | 22 | 12 | – | – | – | – | – | 75 | 39.5 | | | | |
| | October | Male | 4 | 32 | 46 | 82 | 37 | 59 | 57 | 63 | 38 | 6 | 4 | – | 428 | 43.8 | 0.63 | 474 | 1 467 | 216 |
| | | Female | – | 25 | 36 | 4 | 7 | 23 | 1 | 7 | – | – | – | – | 103 | 35.4 | | | | |

TABLE 7—*continued*

| Year | Month | Sex | Carapace length distribution of catch of sampled boats (5 mm groups) | | | | | | | | | | | Total | Mean length (mm) | Landings (cwt) | | Effort (hours) all boats | Number of *Nephrops* measured |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73– | | | sampled boats | all boats | |
| 1964 | February | Male | – | 1 | 7 | 10 | 19 | 16 | 3 | – | 1 | – | – | – | 57 | 40.4 | 0.06 | 477 | 1 297 | 82 |
| | | Female | 1 | 1 | 6 | 4 | 7 | 3 | 2 | 1 | – | – | – | – | 25 | 37.9 | | | | |
| | May | Male | – | 8 | 25 | 62 | 156 | 137 | 91 | 53 | 17 | 7 | 3 | – | 559 | 44.6 | 0.69 | 4 | 28 | 309 |
| | | Female | – | 8 | 15 | 21 | 31 | 6 | 2 | – | – | – | – | – | 83 | 36.6 | | | | |
| | June | Male | – | – | 2 | 3 | 15 | 7 | 8 | 9 | 18 | 7 | 1 | – | 70 | 51.6 | 0.13 | 0 | 0 | 78 |
| | | Female | – | – | 1 | – | 2 | 3 | 2 | – | – | – | – | – | 8 | 43.6 | | | | |
| | July | Male | – | 8 | 38 | 139 | 147 | 115 | 84 | 48 | 38 | 35 | 18 | 4 | 674 | 45.3 | 0.91 | 0 | 0 | 527 |
| | | Female | – | 2 | 22 | 32 | 27 | 22 | 9 | – | – | – | – | – | 114 | 38.7 | | | | |
| | August | Male | – | 5 | 27 | 40 | 52 | 54 | 47 | 44 | 29 | 20 | 11 | 2 | 331 | 47.6 | 0.48 | 0 | 0 | 384 |
| | | Female | – | 6 | 22 | 3 | 10 | 8 | 3 | 1 | – | – | – | – | 53 | 36.0 | | | | |
| | October | Male | – | 30 | 118 | 193 | 149 | 107 | 72 | 67 | 72 | 47 | 4 | – | 859 | 43.3 | 1.38 | 136 | 468 | 211 |
| | | Female | 4 | 29 | 62 | 59 | 60 | 41 | 22 | – | 11 | – | – | – | 288 | 37.8 | | | | |
| | November | Male | – | 2 | 41 | 64 | 81 | 25 | 10 | 2 | 6 | 9 | 5 | – | 245 | 40.5 | 0.19 | 216 | 675 | 140 |
| | | Female | – | 4 | 23 | 16 | 13 | 5 | 9 | – | – | – | – | – | 70 | 36.9 | | | | |
| 1965 | January | Male | – | 16 | 421 | 1 352 | 1 948 | 2 473 | 391 | 74 | 95 | 114 | 4 | – | 6 888 | 42.1 | 6.13 | 160 | 312 | 440 |
| | | Female | – | 32 | 514 | 748 | 155 | 91 | 33 | 62 | – | – | – | – | 1 635 | 35.8 | | | | |
| | February | Male | – | 12 | 278 | 501 | 1 413 | 1 236 | 486 | 161 | 102 | 102 | – | – | 4 291 | 43.4 | 4.81 | 353 | 712 | 381 |
| | | Female | 8 | 32 | 181 | 171 | 123 | 272 | 176 | 103 | – | – | – | – | 1 066 | 41.8 | | | | |
| | March | Male | – | – | 1 195 | 2 557 | 2 410 | 2 082 | 479 | 256 | 85 | 6 | – | – | 9 070 | 40.1 | 10.38 | 1 566 | 2 286 | 447 |
| | | Female | – | – | 1 086 | 1 784 | 865 | 1 732 | 571 | – | – | – | – | – | 6 038 | 39.6 | | | | |
| | April | Male | – | – | 564 | 1 103 | 413 | 256 | 120 | 24 | 8 | – | – | – | 2 488 | 37.2 | 2.25 | 707 | 1 700 | 203 |
| | | Female | – | 70 | 745 | 812 | 136 | 32 | 40 | – | – | – | – | – | 1 835 | 34.0 | | | | |
| | May | Male | – | 17 | 166 | 233 | 322 | 240 | 99 | 11 | 33 | 11 | 11 | – | 1 143 | 41.0 | 1.13 | 560 | 1 341 | 189 |
| | | Female | – | 21 | 144 | 64 | 44 | 33 | 11 | – | – | – | – | – | 317 | 34.8 | | | | |
| | June | Male | – | 4 | 17 | 61 | 168 | 262 | 212 | 159 | 94 | 27 | 11 | 9 | 1 024 | 48.8 | 1.81 | 5 | 27 | 242 |
| | | Female | – | 2 | 11 | 25 | 21 | – | 38 | 9 | – | – | – | – | 106 | 42.9 | | | | |
| | July | Male | – | – | 1 | 19 | 88 | 109 | 170 | 128 | 124 | 52 | 30 | 8 | 729 | 52.9 | 1.44 | 30 | 138 | 407 |
| | | Female | – | – | 8 | 3 | 10 | 8 | 2 | 1 | – | – | – | – | 32 | 39.9 | | | | |
| | August | Male | – | – | 91 | 209 | 275 | 273 | 128 | 35 | 39 | 35 | 36 | 2 | 1 123 | 44.1 | 1.50 | 31 | 188 | 285 |
| | | Female | – | – | 60 | 62 | 21 | 32 | 13 | – | – | – | – | – | 188 | 37.2 | | | | |

TABLE 7—*continued*

| Year | Month | Sex | Carapace length distribution of catch of sampled boats (5 mm groups) | | | | | | | | | | | | Total | Mean length (mm) | Landings (cwt) | | Effort (hours) all boats | Number of *Nephrops* measured |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | | sampled boats | all boats | | |
| 1966 | October | Male | 108 | 350 | 641 | 941 | 876 | 908 | 878 | 411 | 111 | 97 | 9 | – | 5 330 | 41.6 | 7.75 | 780 | 1 948 | 735 |
| | | Female | 40 | 236 | 443 | 1 220 | 504 | 482 | 223 | 79 | – | – | – | – | 3 227 | 37.7 | | | | |
| | November | Male | – | 263 | 1 230 | 3 836 | 2 370 | 2 778 | 2 748 | 1 127 | 218 | 90 | – | 30 | 14 690 | 42.6 | 23.81 | 1 660 | 2 683 | 1 061 |
| | | Female | – | 513 | 1 566 | 4 740 | 3 927 | 2 066 | 1 455 | 341 | – | – | – | – | 14 608 | 39.3 | | | | |
| | December | Male | – | 12 | 826 | 2 428 | 1 974 | 1 891 | 629 | 381 | 76 | – | – | – | 8 217 | 40.8 | 12.56 | 1 483 | 2 922 | 586 |
| | | Female | – | 338 | 621 | 3 712 | 1 346 | 1 674 | 928 | 105 | – | – | – | – | 8 724 | 39.3 | | | | |
| 1967 | January | Male | – | 43 | 611 | 650 | 560 | 956 | 720 | 266 | 32 | – | – | – | 3 838 | 42.2 | 4.88 | 892 | 2 900 | 491 |
| | | Female | – | 44 | 291 | 334 | 126 | 225 | 154 | 33 | – | – | – | – | 1 207 | 38.8 | | | | |
| | February | Male | – | 119 | 597 | 493 | 340 | 300 | 320 | 120 | 60 | 80 | – | – | 2 429 | 40.3 | 2.94 | 625 | 1 778 | 182 |
| | | Female | 7 | 175 | 395 | 208 | 120 | 40 | 20 | 20 | – | – | – | – | 985 | 33.3 | | | | |
| | March | Male | – | 38 | 331 | 424 | 1 021 | 1 348 | 890 | 552 | 105 | 58 | – | – | 4 767 | 45.0 | 8.63 | 68 | 463 | 334 |
| | | Female | – | 69 | 192 | 860 | 544 | 148 | 244 | 20 | – | – | – | – | 2 077 | 38.7 | | | | |
| | June | Male | – | 14 | 78 | 44 | 28 | 120 | 180 | 300 | 200 | 60 | 60 | 40 | 1 124 | 53.3 | 2.63 | 241 | 1 013 | 193 |
| | | Female | – | 24 | 66 | 46 | 6 | – | 20 | – | – | – | – | – | 162 | 34.0 | | | | |
| | September | Male | – | 9 | 72 | 78 | 661 | 1 119 | 652 | 931 | 231 | 46 | – | – | 3 799 | 48.6 | 6.00 | 1 435 | 3 761 | 220 |
| | | Female | 6 | 151 | 66 | 145 | 199 | 418 | 46 | 92 | – | – | – | – | 1 123 | 40.6 | | | | |
| | October | Male | 48 | 123 | 1 371 | 1 942 | 1 020 | 710 | 885 | 561 | 65 | – | – | 24 | 6 749 | 40.0 | 13.63 | 1 067 | 2 768 | 482 |
| | | Female | 117 | 180 | 1 235 | 1 293 | 2 139 | 1 293 | 536 | 24 | – | – | – | – | 6 817 | 38.8 | | | | |
| | November | Male | 302 | 2 859 | 3 468 | 3 514 | 1 203 | 690 | 337 | 198 | 190 | 80 | 12 | – | 12 853 | 33.9 | 12.44 | 1 459 | 3 629 | 800 |
| | | Female | 974 | 5 020 | 2 855 | 2 299 | 1 934 | 660 | 344 | 15 | 38 | – | – | – | 14 139 | 31.5 | | | | |
| | December | Male | 50 | 1 250 | 1 850 | 2 150 | 450 | 525 | 325 | 100 | 50 | - | - | – | 6 750 | 34.5 | 6.25 | 802 | 2 170 | 323 |
| | | Female | 300 | 1 300 | 1 600 | 1 275 | 875 | 550 | 250 | – | – | – | – | – | 6 150 | 33.6 | | | | |

E 8 *Comparison of the percentage length compositions of* Nephrops *(both sexes combined) in the laboratory (L) and market (M) samples, when both were taken in the same month*

| Month | Sample | Carapace length (5 mm groups) | | | | | | | | | | | | Number measured | Mean length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | |
| August | L | 0.3 | 7.4 | 14.2 | 17.9 | 19.7 | 14.8 | 8.0 | 8.6 | 4.3 | 2.5 | 1.9 | 0.3 | 324 | 42.0 |
| | M | – | 0.5 | 4.2 | 9.8 | 11.6 | 23.4 | 18.7 | 19.3 | 6.8 | 4.0 | 1.7 | – | 381 | 48.3 |
| September | L | 0.8 | 5.6 | 13.2 | 10.8 | 15.2 | 11.2 | 14.0 | 10.8 | 10.8 | 6.4 | 1.2 | – | 250 | 45.3 |
| | M | – | – | 1.6 | 4.4 | 18.4 | 28.8 | 26.0 | 12.1 | 3.5 | 4.8 | 0.4 | – | 190 | 48.0 |
| October | L | 0.6 | 11.9 | 19.1 | 20.6 | 21.6 | 12.3 | 5.5 | 5.1 | 2.8 | 0.6 | – | – | 472 | 38.3 |
| | M | 1.4 | 4.6 | 11.3 | 20.5 | 28.2 | 19.5 | 8.2 | 3.2 | 2.1 | 0.4 | 0.6 | – | 340 | 40.4 |
| November | L | 5.9 | 20.8 | 36.1 | 15.7 | 10.7 | 6.8 | 2.1 | 0.5 | 0.5 | 0.7 | 0.1 | – | 750 | 32.8 |
| | M | 0.5 | 1.7 | 13.7 | 20.4 | 27.4 | 19.0 | 5.2 | 5.6 | 2.8 | 2.1 | 1.6 | – | 244 | 41.6 |
| December | L | – | 15.3 | 21.7 | 16.0 | 27.4 | 15.8 | 3.0 | 0.5 | 0.4 | – | – | – | 563 | 36.5 |
| | M | – | 1.8 | 10.1 | 15.5 | 29.8 | 29.0 | 6.4 | 2.7 | 3.7 | 1.0 | – | – | 110 | 41.9 |
| January | L | 0.4 | 13.0 | 23.0 | 16.4 | 22.6 | 18.2 | 4.9 | 1.3 | – | – | – | 0.2 | 548 | 37.0 |
| | M | – | 5.4 | 10.1 | 16.4 | 24.7 | 28.2 | 9.2 | 3.8 | 1.1 | 0.9 | 0.1 | – | 611 | 41.2 |
| April | L | 0.6 | 6.3 | 30.5 | 18.9 | 25.0 | 11.6 | 4.0 | 1.5 | 1.1 | 0.4 | – | – | 524 | 37.0 |
| | M | – | 10.5 | 18.6 | 16.3 | 22.7 | 20.3 | 9.3 | 1.8 | – | 0.6 | – | – | 172 | 38.6 |
| August | L | – | 1.5 | 9.3 | 17.1 | 15.1 | 16.1 | 15.6 | 14.1 | 7.8 | 2.0 | 1.5 | – | 205 | 45.5 |
| | M | – | 1.7 | 5.0 | 14.9 | 19.1 | 17.7 | 17.9 | 9.0 | 6.7 | 6.0 | 2.0 | – | 151 | 46.5 |
| October | L | 2.6 | 7.4 | 27.0 | 15.8 | 16.0 | 13.4 | 6.2 | 3.3 | 3.6 | 3.6 | 1.0 | – | 418 | 39.1 |
| | M | 0.8 | 10.7 | 15.4 | 16.2 | 8.3 | 15.4 | 10.9 | 13.2 | 7.2 | 1.1 | 0.8 | – | 216 | 42.2 |
| May | L | – | 2.3 | 13.5 | 19.2 | 22.9 | 20.6 | 11.2 | 4.9 | 3.4 | 0.8 | 1.1 | – | 349 | 42.0 |
| | M | – | 2.5 | 6.2 | 12.9 | 29.1 | 22.3 | 14.5 | 8.3 | 2.6 | 1.1 | 0.5 | – | 309 | 43.6 |
| August | L | – | – | 4.3 | 15.4 | 12.3 | 18.5 | 11.1 | 11.7 | 14.2 | 8.0 | 4.3 | – | 162 | 49.2 |
| | M | – | 2.9 | 12.8 | 11.2 | 16.1 | 16.1 | 13.0 | 11.7 | 7.6 | 5.2 | 2.9 | 0.5 | 384 | 46.0 |
| October | L | 0.5 | 13.5 | 16.7 | 20.0 | 15.2 | 15.2 | 11.8 | 4.6 | 2.2 | 0.2 | – | – | 414 | 38.8 |
| | M | 0.3 | 5.1 | 15.7 | 22.0 | 18.2 | 12.9 | 8.2 | 5.8 | 7.2 | 4.1 | 0.3 | – | 211 | 41.9 |
| November | L | 1.7 | 12.1 | 33.3 | 26.1 | 16.9 | 7.1 | 1.9 | 0.3 | 0.2 | 0.2 | 0.2 | – | 579 | 34.4 |
| | M | - | 1.9 | 20.3 | 25.4 | 29.8 | 9.5 | 6.0 | 0.6 | 1.9 | 2.9 | 1.6 | – | 140 | 39.7 |
| January | L | – | – | 2.1 | 6.6 | 26.1 | 25.7 | 26.1 | 12.4 | 0.4 | 0.4 | – | – | 241 | 45.9 |
| | M | – | 0.6 | 11.0 | 24.6 | 24.7 | 30.1 | 5.0 | 1.6 | 1.1 | 1.3 | – | – | 440 | 40.9 |
| February | L | – | – | 8.8 | 12.0 | 21.6 | 20.0 | 26.0 | 5.2 | 4.4 | 1.6 | 0.4 | – | 250 | 44.8 |
| | M | 0.1 | 0.8 | 8.6 | 12.5 | 28.7 | 28.1 | 12.4 | 4.9 | 1.9 | 1.9 | – | – | 381 | 43.1 |
| March | L | – | 0.8 | 11.5 | 11.5 | 37.3 | 24.2 | 8.6 | 2.4 | 2.0 | 0.8 | 0.8 | – | 244 | 42.0 |
| | M | – | – | 15.1 | 28.7 | 21.7 | 25.2 | 6.9 | 1.7 | 0.6 | – | – | – | 447 | 39.9 |
| April | L | 0.2 | 3.7 | 35.1 | 30.8 | 17.9 | 9.3 | 2.2 | 0.6 | 0.2 | – | – | – | 464 | 35.7 |
| | M | – | 1.6 | 30.3 | 44.3 | 12.7 | 6 7 | 3.7 | 0.6 | 0.2 | – | – | – | 203 | 35.8 |
| August | L | – | 3.0 | 19.3 | 27.0 | 20.0 | 15.3 | 7.2 | 3.4 | 2.5 | 1.7 | 0.6 | – | 471 | 39.9 |
| | M | – | – | 11.5 | 20.7 | 22 6 | 23.3 | 10.8 | 2.7 | 3.0 | 2.7 | 2.7 | 0.2 | 285 | 43.1 |
| 5 October | L | 2.5 | 9.3 | 20.1 | 33.6 | 14.9 | 11.5 | 6.6 | 0.6 | 0.3 | 0.3 | – | 0.1 | 676 | 36.4 |
| | M | 1.7 | 6.8 | 12.7 | 25.3 | 16.1 | 16.2 | 12.9 | 5.7 | 1.3 | 1.1 | 0.1 | – | 735 | 40.1 |
| November | L | 0.2 | 3.3 | 6.5 | 21.7 | 29.0 | 25.2 | 12.1 | 1.7 | 0.2 | – | – | – | 461 | 41.0 |
| | M | – | 2.6 | 9.5 | 29.3 | 21.5 | 16 5 | 14.3 | 5.0 | 0.7 | 0.3 | – | 0.1 | 1 061 | 41.0 |
| 7 February | L | 0.3 | 6.7 | 22.2 | 22.7 | 15.9 | 15.9 | 10.0 | 4.5 | 1.4 | 0.2 | 0.1 | – | 910 | 38.9 |
| | M | 0.2 | 8.6 | 29.1 | 20.5 | 13.5 | 10.0 | 10.0 | 4.1 | 1.8 | 2.3 | – | – | 182 | 38.3 |
| June | L | – | 0.9 | 6.6 | 5.7 | 7.0 | 13.2 | 22.5 | 19.4 | 15.4 | 6.2 | 3.1 | – | 227 | 50.8 |
| | M | – | 3.0 | 11.2 | 7.0 | 2.6 | 9.3 | 15.6 | 23.3 | 15.6 | 4.7 | 4.7 | 3.1 | 193 | 50.9 |
| September | L | 1.5 | 2.2 | 8.4 | 7.7 | 19.1 | 25.0 | 19.8 | 12.9 | 2.9 | 0.4 | – | – | 272 | 44.5 |
| | M | 0.1 | 3.3 | 2.8 | 4.5 | 17.5 | 31.2 | 14.2 | 20.8 | 4.7 | 0.9 | – | – | 220 | 46.8 |
| October | L | 3.0 | 17.3 | 40.2 | 20.0 | 9.9 | 6.0 | 2.6 | 0.8 | – | 0.1 | – | – | 819 | 33.0 |
| | M | 1.2 | 2.2 | 19.2 | 23.8 | 23.3 | 14.8 | 10.5 | 4.3 | 0.5 | – | – | 0.2 | 482 | 39.4 |
| November | L | 6.4 | 25.8 | 37.7 | 20.7 | 4.4 | 3.3 | 1.2 | 0.5 | 0.1 | – | – | – | 823 | 30.9 |
| | M | 4.7 | 29.2 | 23.4 | 21.5 | 11.6 | 5.0 | 2.5 | 0.8 | 0.8 | 0.3 | – | – | 800 | 32.6 |

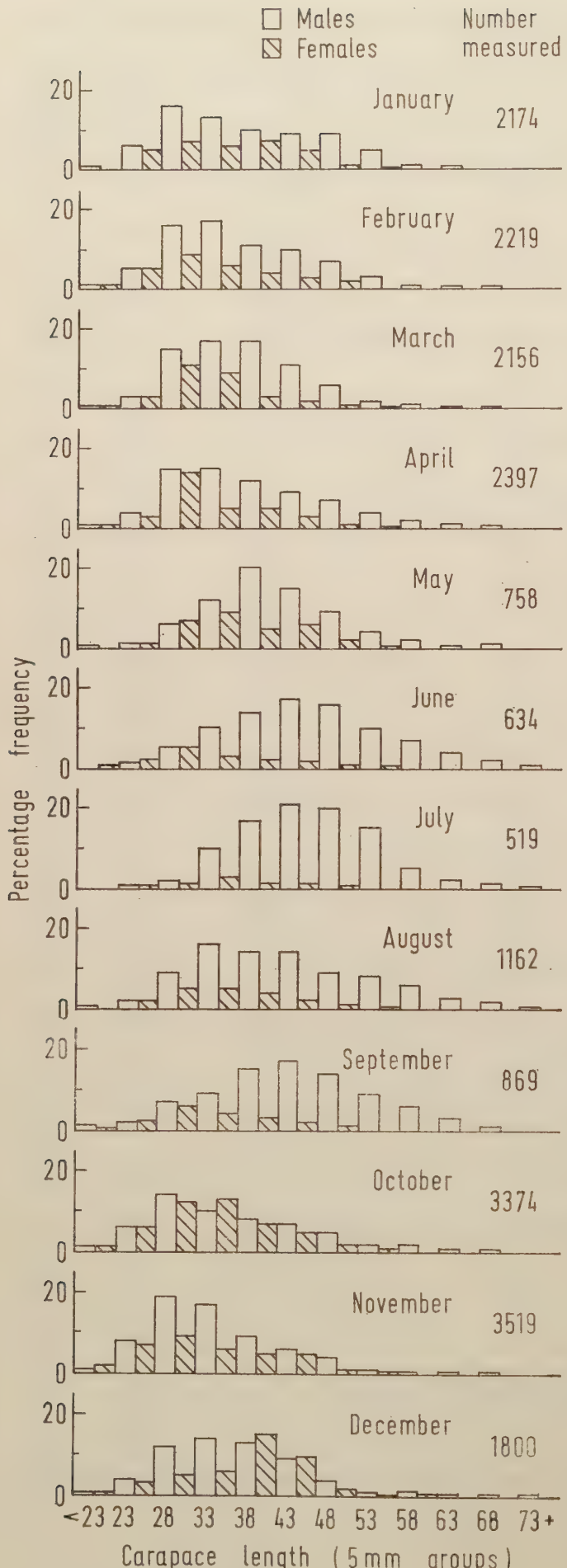



Fig. 7 Percentage carapace length compositions of male and female *Nephrops* in the laboratory samples, mean monthly values for 1962 to 1968 inclusive.

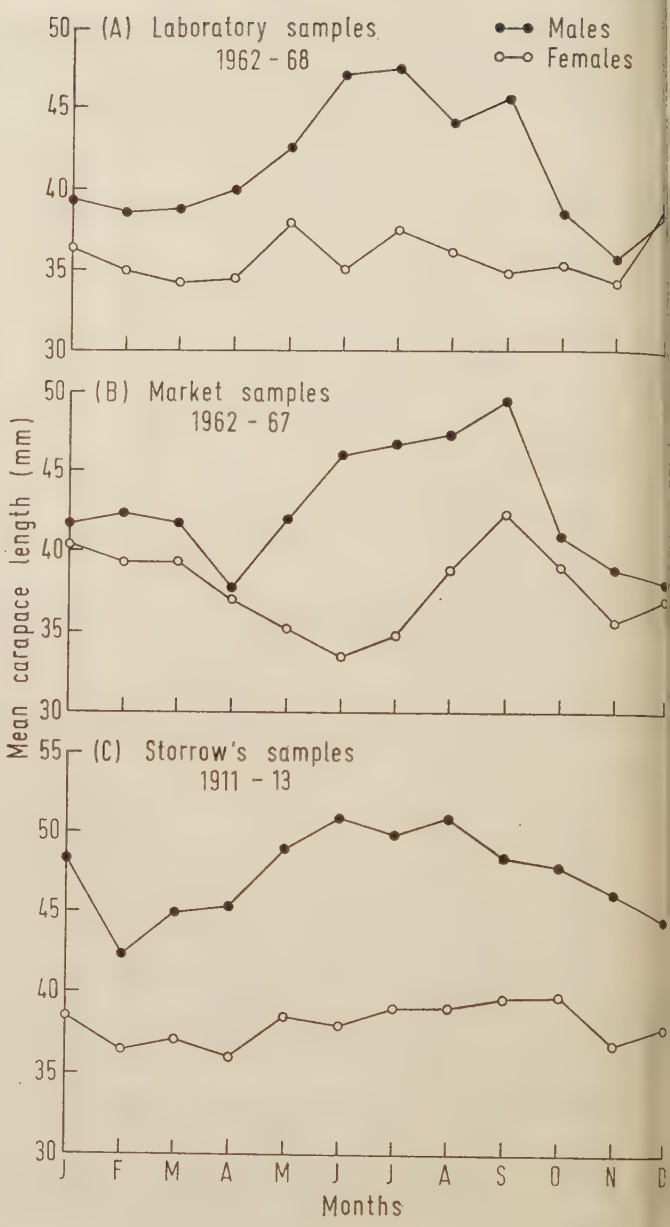

(A) Laboratory samples 1962 - 68
Males
Females
(B) Market samples 1962 - 67
Mean carapace length (mm)
(C) Storrow's samples 1911 - 13
J F M A M J J A S O N D
Months

Fig. 8 Mean monthly carapace lengths of male and female *Nephrops*: (A) laboratory samples, 1962 to 1968; (B) market samples, 1962 to 1967; and (C) Storrow's samples, 1911 to 1913

Market measurements were rarely made on the catch of the trawler from which the laboratory sample was taken. Despite the possibility that the samples may have been taken on different parts of the ground, and that variations in the design and rig of the trawl or other causes may have resulted in differences in the size of *Nephrops* landed, the length compositions of the two types of sample were, in the majority of cases, similar. Where differences were found the means of the laboratory samples were more often lower than those of the market samples, suggesting that, because the laboratory samples were taken direct from the trawl before sorting, at least some rejection of small *Nephrops* occurred at sea.

No completely consistent seasonal patterns in the carapace length distributions were found for either the males or females in the two types of samples (Tables 6 and 7). However, in general, the larger size groups of the males were better represented in the samples taken in June, July and August than at any other time of the year, and there was a marked increase in the proportion of the lower size groups in October or November each year. These conclusions are shown in Figure 7 which gives the mean monthly percentage

LE 9 *North Shields* Nephrops; *carapace length distributions and mean values, 1911–13 (data from Storrow 1912, 1913)*

| Month | Sex | Carapace length (5 mm groups) | | | | | | | | | | | | Total number | Mean length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | | |
| May | Male | – | 3 | 6 | 35 | 67 | 121 | 148 | 139 | 49 | 9 | 1 | – | 578 | 48.9 |
| | Female | – | 2 | 17 | 42 | 72 | 30 | 3 | 1 | – | – | – | – | 167 | 38.7 |
| June | Male | – | – | 2 | 17 | 31 | 78 | 122 | 116 | 57 | 17 | 2 | – | 442 | 51.0 |
| | Female | – | – | 2 | 12 | 9 | 5 | – | – | – | – | – | – | 28 | 38.0 |
| July | Male | – | 2 | 10 | 48 | 122 | 222 | 324 | 270 | 146 | 31 | 1 | – | 1 176 | 50.0 |
| | Female | 2 | 4 | 10 | 24 | 34 | 24 | 10 | 1 | – | – | – | – | 109 | 39.2 |
| August | Male | – | 1 | 9 | 40 | 99 | 173 | 303 | 296 | 164 | 32 | 3 | – | 1 120 | 50.9 |
| | Female | – | 4 | 11 | 57 | 73 | 45 | 7 | – | – | – | – | – | 197 | 39.2 |
| September | Male | – | 1 | 1 | 4 | 31 | 62 | 68 | 44 | 13 | 1 | – | – | 225 | 48.4 |
| | Female | – | – | 2 | 17 | 23 | 11 | 2 | 1 | – | – | – | – | 56 | 39.7 |
| October | Male | – | – | 3 | 18 | 58 | 89 | 66 | 68 | 26 | 4 | – | – | 332 | 47.9 |
| | Female | – | – | 9 | 65 | 102 | 50 | 13 | – | – | – | – | – | 239 | 39.9 |
| November | Male | 1 | 13 | 14 | 24 | 38 | 61 | 63 | 52 | 25 | 2 | – | – | 293 | 46.1 |
| | Female | 4 | 8 | 28 | 80 | 70 | 26 | 5 | 1 | – | – | – | – | 222 | 36.9 |
| December | Male | 4 | 3 | 28 | 36 | 70 | 72 | 66 | 36 | 23 | 5 | – | – | 343 | 44.5 |
| | Female | 3 | 9 | 32 | 113 | 115 | 60 | 5 | – | – | – | – | – | 337 | 37.8 |
| January | Male | – | 2 | 17 | 24 | 64 | 103 | 83 | 85 | 54 | 14 | 1 | – | 447 | 48.4 |
| | Female | – | 4 | 7 | 30 | 35 | 32 | 7 | 1 | – | – | – | – | 116 | 39.7 |
| February | Male | 4 | 8 | 57 | 43 | 74 | 48 | 35 | 50 | 32 | 6 | – | – | 357 | 43.2 |
| | Female | 5 | 14 | 58 | 96 | 95 | 35 | 11 | 1 | – | – | – | – | 315 | 36.6 |
| April | Male | 7 | 19 | 62 | 30 | 36 | 48 | 49 | 53 | 24 | 8 | 1 | – | 337 | 43.1 |
| | Female | 4 | 10 | 52 | 82 | 83 | 17 | 2 | – | – | – | – | – | 250 | 35.8 |
| February | Male | 7 | 9 | 45 | 28 | 59 | 46 | 30 | 25 | 12 | 2 | 1 | – | 264 | 41.4 |
| | Female | 6 | 8 | 52 | 79 | 74 | 28 | 8 | – | – | – | – | – | 255 | 36.3 |
| March | Male | 2 | 8 | 34 | 55 | 52 | 91 | 99 | 66 | 25 | 3 | – | – | 435 | 45.1 |
| | Female | 5 | 12 | 50 | 96 | 114 | 56 | 3 | 1 | – | – | – | – | 337 | 37.2 |
| April | Male | 1 | 5 | 14 | 10 | 52 | 64 | 58 | 47 | 34 | 16 | 2 | – | 303 | 48.1 |
| | Female | 2 | 20 | 39 | 79 | 76 | 32 | 7 | – | – | – | – | – | 255 | 36.5 |

npositions of the laboratory samples for the period 1962 1968 inclusive.

Details of total length distributions of *Nephrops* caught North Shields trawlers in 1911, 1912 and 1913 are given Storrow (1912, 1913). These total lengths, from the trum to the end of the telson measured to the nearest timetre, have been converted to carapace lengths and presented on a monthly basis in Table 9. In general the dal and mean lengths were higher than in the present estigation but this does not necessarily indicate a reduc- n in the size of *Nephrops* on the fishing grounds since 1, for, although most of Storrow's samples were taken aight from the trawl before sorting, no information is ilable on the mesh of the net or other details of the trawls d.

The changes in the size distributions of the *Nephrops* are lected in the mean lengths summarized in Figure 8 as rage monthly mean values. In both the present and Stor- v's investigations, the mean lengths of the females were rmally lower than those of the males and showed less sonal variation.

The length measurements of the market samples given in ble 7 have been raised to give estimates of the catch per it effort (numbers of *Nephrops* per 1 hour's fishing) by ected North Shields *Nephrops* trawlers in each month of mpling, and these are given in Table 10. As in the labora- y samples, no real consistency is seen in the seasonal pattern from year to year. However, in June, July and August of each year that sampling was carried out, there was a considerable reduction in the catch per unit effort of all size groups of male *Nephrops*, with the greatest decrease occurring in the smaller size groups. From October onwards, the catch per unit effort of the smaller size groups of *Nephrops* increased. The females showed somewhat similar trends to the males, with the catch per unit effort of all size groups being at a minimum during June, July and August.

The significance of these seasonal changes in length compositions is not clearly understood. It may be that recruitment of small *Nephrops* to the fishable stock is at a maximum during the autumn, resulting in a decrease in the mean length of the population. Large numbers of small unmarketable individuals are not normally caught on the North Shields fishing grounds (Cole 1965); hence, recruitment is unlikely to be through an increase in size (at moulting) by small *Nephrops* already on the grounds, but more likely because of changes in their behaviour making them more liable to capture by the fishing gear. There is no evidence to suggest that small *Nephrops* recruit to the fishing grounds by migration from other areas.

The seasonal differences in the proportions of large and small *Nephrops* have occasionally contributed in part to marketing problems at North Shields, where the demand is mainly for large *Nephrops*. This was particularly true in the autumns of 1967, 1968 and 1969, when the large catches by the trawlers contained a high proportion of small *Nephrops*.

TABLE 10 *Monthly catch per unit effort (number per 1 hour's fishing) of male and female* Nephrops *in each 5 mm carapace length group by selected* Nephrops *trawlers landing at North Shields*

| Year | Month | Sex | Carapace length (5 mm groups) | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | |
| 1962 | June | Male | 0.3 | 9.8 | 14.2 | 15.0 | 15.0 | 13.3 | 14.8 | 12.8 | 6.7 | 3.9 | 0.4 | – | 106.2 |
| | | Female | 0.6 | 11.9 | 10.0 | 5.0 | 6.0 | 3.1 | 0.4 | – | – | – | – | – | 37.0 |
| | July | Male | 0.7 | 3.0 | 10.6 | 6.0 | 11.6 | 10.2 | 13.9 | 10.9 | 6.9 | 2.6 | 0.8 | 0.3 | 77.5 |
| | | Female | 0.7 | 3.9 | 5.1 | 5.2 | 4.0 | 1.9 | 0.4 | – | – | – | – | – | 21.2 |
| | August | Male | – | 0.2 | 1.9 | 3.4 | 5.2 | 13.5 | 11.6 | 13.3 | 4.7 | 2.8 | 1.2 | – | 57.8 |
| | | Female | – | 0.2 | 1.0 | 3.4 | 2.8 | 2.7 | 1.3 | – | – | – | – | – | 11.4 |
| | September | Male | – | – | 0.9 | 4.1 | 11.3 | 40.2 | 40.6 | 24.7 | 7.3 | 10.1 | 0.9 | – | 140.1 |
| | | Female | – | – | 2.6 | 5.1 | 27.4 | 20.5 | 14.1 | 0.9 | – | – | – | – | 70.6 |
| | October | Male | 4.7 | 18.1 | 42.3 | 51.4 | 36.8 | 41.8 | 30.1 | 15.9 | 10.7 | 2.1 | 3.1 | – | 257.0 |
| | | Female | 2.3 | 4.7 | 14.0 | 50.9 | 104.0 | 55.9 | 10.7 | – | – | – | – | – | 242.5 |
| | November | Male | 2.2 | 2.3 | 39.8 | 44.8 | 40.5 | 25.7 | 18.0 | 20.6 | 11.6 | 8.5 | 6.6 | – | 220.6 |
| | | Female | – | 4.5 | 16.5 | 38.9 | 71.7 | 52.2 | 3.4 | 2.2 | – | – | – | – | 189.4 |
| | December | Male | – | 11.7 | 47.8 | 89.3 | 142.5 | 124.5 | 36.0 | 18.0 | 24.3 | 6.3 | – | – | 500.4 |
| | | Female | – | – | 18.8 | 12.5 | 54.0 | 66.6 | 6.3 | – | – | – | – | – | 158.2 |
| 1963 | January | Male | – | 16.5 | 23.9 | 30.9 | 30.8 | 29.4 | 16.3 | 14.3 | 4.7 | 3.9 | 0.3 | – | 171.0 |
| | | Female | – | 6.7 | 19.1 | 39.1 | 74.2 | 90.6 | 22.9 | 2.1 | – | – | – | – | 254.7 |
| | February | Male | – | 3.6 | 14.4 | 9.0 | 16.2 | 14.4 | 12.6 | 5.4 | 3.6 | 1.8 | – | 1.8 | 82.8 |
| | | Female | – | 9.0 | 23.4 | 21.6 | 79.2 | 72.1 | 16.2 | – | – | – | – | – | 221.5 |
| | April | Male | – | 9.3 | 18.5 | 20.4 | 11.1 | 14.8 | 9.3 | 3.7 | – | 1.9 | – | – | 89.0 |
| | | Female | – | 24.1 | 40.8 | 31.5 | 61.2 | 50.1 | 20.4 | 1.9 | – | – | – | – | 230.0 |
| | August | Male | – | 2.1 | 2.1 | 14.1 | 23.7 | 17.4 | 19.7 | 11.2 | 8.3 | 7.5 | 2.5 | – | 108.6 |
| | | Female | – | – | 4.2 | 4.4 | – | 4.6 | 2.5 | – | – | – | – | – | 15.7 |
| | October | Male | 2.1 | 16.5 | 23.8 | 42.4 | 19.1 | 30.5 | 29.5 | 32.6 | 19.6 | 3.1 | 2.1 | – | 221.3 |
| | | Female | – | 12.9 | 18.6 | 2.1 | 3.6 | 11.9 | 0.5 | 3.6 | – | – | – | – | 53.2 |
| 1964 | February | Male | – | 5.9 | 41.2 | 58.8 | 111.8 | 94.2 | 17.7 | – | 5.9 | – | – | – | 335.5 |
| | | Female | 5.9 | 5.9 | 35.3 | 23.5 | 41.2 | 17.7 | 11.8 | 5.9 | – | – | – | – | 147.2 |
| | May | Male | – | 1.6 | 5.2 | 12.9 | 32.4 | 28.5 | 18.9 | 11.0 | 3.5 | 1.5 | 0.6 | – | 116.1 |
| | | Female | – | 1.6 | 3.1 | 4.4 | 6.4 | 1.3 | 0.4 | – | – | – | – | – | 17.2 |
| | October | Male | – | 6.3 | 24.9 | 40.8 | 31.5 | 22.6 | 15.2 | 14.2 | 15.2 | 9.9 | 0.8 | – | 181.4 |
| | | Female | 0.8 | 6.1 | 13.1 | 12.5 | 12.7 | 8.7 | 4.7 | – | 2.3 | – | – | – | 60.9 |
| | November | Male | – | 3.4 | 70.0 | 109.2 | 138.2 | 42.7 | 17.1 | 3.4 | 10.2 | 15.4 | 8.5 | – | 418.1 |
| | | Female | – | 6.8 | 39.3 | 27.3 | 22.2 | 8.5 | 15.4 | – | – | – | – | – | 119.5 |
| 1965 | January | Male | – | 1.3 | 35.2 | 113.2 | 163.1 | 207.0 | 32.7 | 6.2 | 8.0 | 9.5 | 0.3 | – | 576.5 |
| | | Female | – | 2.7 | 43.0 | 62.6 | 13.0 | 7.6 | 2.8 | 5.2 | – | – | – | – | 136.9 |
| | February | Male | – | 1.2 | 28.6 | 51.6 | 145.6 | 127.3 | 50.1 | 16.6 | 10.5 | 10.5 | – | – | 442.0 |
| | | Female | 0.8 | 3.3 | 18.6 | 17.6 | 12.7 | 28.0 | 18.1 | 10.6 | – | – | – | – | 109.7 |
| | March | Male | – | – | 78.9 | 168.8 | 159.1 | 137.5 | 31.6 | 16.9 | 5.6 | 0.4 | – | – | 598.8 |
| | | Female | – | – | 71.7 | 117.8 | 57.1 | 114.4 | 37.7 | – | – | – | – | – | 398.7 |
| | April | Male | – | – | 104.2 | 203.9 | 76.3 | 47.3 | 22.2 | 4.4 | 1.5 | – | – | – | 459.8 |
| | | Female | – | 12.9 | 137.7 | 150.1 | 25.1 | 5.9 | 7.4 | – | – | – | – | – | 339.1 |
| | May | Male | – | 6.3 | 61.6 | 86.5 | 119.5 | 89.1 | 36.7 | 4.1 | 12.3 | 4.1 | 4.1 | – | 424.3 |
| | | Female | – | 7.8 | 53.5 | 23.8 | 16.3 | 12.3 | 4.1 | – | – | – | – | – | 117.8 |
| | June | Male | – | 0.4 | 1.7 | 6.2 | 17.2 | 26.8 | 21.7 | 16.3 | 9.6 | 2.7 | 1.1 | 0.9 | 104.6 |
| | | Female | – | 0.2 | 1.1 | 2.6 | 2.1 | – | 3.9 | 0.9 | – | – | – | – | 10.8 |
| | July | Male | – | – | 0.2 | 2.9 | 13.3 | 16.5 | 25.7 | 19.4 | 18.8 | 7.9 | 4.5 | 1.2 | 110.4 |
| | | Female | – | – | 1.2 | 0.5 | 1.5 | 1.2 | 0.3 | 0.2 | – | – | – | – | 4.9 |
| | August | Male | – | – | 10.0 | 23.0 | 30.2 | 30.0 | 14.1 | 3.8 | 4.3 | 3.8 | 4.0 | 0.2 | 123.4 |
| | | Female | – | – | 6.6 | 6.8 | 2.3 | 3.5 | 1.4 | – | – | – | – | – | 20.6 |

E 10—*continued*

| Month | Sex | Carapace length (5 mm groups) | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <23 | 23–27 | 28–32 | 33–37 | 38–42 | 43–47 | 48–52 | 53–57 | 58–62 | 63–67 | 68–72 | 73+ | |
| October | Male | 5.6 | 18.1 | 33.1 | 48.6 | 45.3 | 46.9 | 45.4 | 21.2 | 5.7 | 5.0 | 0.5 | – | 275.4 |
| | Female | 2.1 | 12.2 | 22.9 | 63.0 | 26.0 | 24.9 | 11.5 | 4.1 | – | – | – | – | 166.7 |
| November | Male | – | 6.8 | 32.0 | 99.7 | 61.6 | 72.2 | 71.4 | 29.3 | 5.7 | 2.3 | – | 0.8 | 381.8 |
| | Female | – | 13.3 | 40.7 | 123.2 | 102.0 | 53.7 | 37.8 | 8.9 | – | – | – | – | 379.6 |
| December | Male | – | 0.5 | 33.4 | 98.1 | 79.8 | 76.4 | 25.4 | 15.4 | 3.1 | – | – | – | 332.1 |
| | Female | – | 13.7 | 25.1 | 150.0 | 54.4 | 67.6 | 37.5 | 4.2 | – | – | – | – | 352.5 |
| January | Male | – | 2.7 | 38.6 | 41.0 | 35.3 | 60.3 | 45.4 | 16.8 | 2.0 | – | – | – | 242.1 |
| | Female | – | 2.8 | 18.4 | 21.1 | 8.0 | 14.2 | 9.7 | 2.1 | – | – | – | – | 76.3 |
| February | Male | – | 14.2 | 71.4 | 59.0 | 40.7 | 35.9 | 38.3 | 14.4 | 7.2 | 9.6 | – | – | 290.7 |
| | Female | 0.8 | 20.9 | 47.3 | 24.9 | 14.4 | 4.8 | 2.4 | 2.4 | – | – | – | – | 117.9 |
| March | Male | – | 0.7 | 5.6 | 7.2 | 17.4 | 23.0 | 15.2 | 9.4 | 1.8 | 1.0 | – | – | 81.3 |
| | Female | – | 1.2 | 3.3 | 14.6 | 9.3 | 2.5 | 4.2 | 0.3 | – | – | – | – | 35.4 |
| June | Male | – | 1.3 | 7.1 | 4.0 | 2.5 | 10.9 | 16.3 | 27.2 | 18.1 | 5.4 | 5.4 | 3.6 | 101.8 |
| | Female | – | 2.2 | 6.0 | 4.2 | 0.5 | – | 1.8 | – | – | – | – | – | 14.7 |
| September | Male | – | 0.6 | 4.6 | 5.0 | 42.0 | 71.2 | 41.5 | 59.2 | 14.7 | 2.9 | – | – | 241.7 |
| | Female | 0.4 | 9.6 | 4.2 | 9.2 | 12.7 | 26.6 | 2.9 | 5.9 | – | – | – | – | 71.5 |
| October | Male | 1.4 | 3.5 | 38.8 | 54.9 | 28.9 | 20.1 | 25.0 | 15.9 | 1.8 | – | – | 0.7 | 191.0 |
| | Female | 3.3 | 5.1 | 34.9 | 36.6 | 60.5 | 36.6 | 15.2 | 0.7 | – | – | – | – | 192.9 |
| November | Male | 9.8 | 92.4 | 112.1 | 113.6 | 38.9 | 22.3 | 10.9 | 6.4 | 6.1 | 2.6 | 0.4 | – | 415.5 |
| | Female | 31.5 | 162.3 | 92.3 | 74.3 | 62.5 | 21.3 | 11.1 | 0.5 | 1.2 | – | – | – | 457.0 |
| December | Male | 3.0 | 73.9 | 109.4 | 127.1 | 26.6 | 31.1 | 19.2 | 5.9 | 3.0 | – | – | – | 399.2 |
| | Female | 17.7 | 76.9 | 94.6 | 75.4 | 51.7 | 32.5 | 14.8 | – | – | – | – | – | 363.6 |

vell as the decrease in mean length of male *Nephrops*, the ease in the abundance of females, which were generally smaller mean size than the males, during the autumn a contributory factor to the increase in the proportion mall *Nephrops* in the catches.

METRIC RELATIONSHIPS

nalyses of the monthly laboratory samples have in-led the routine measurements of carapace length and l weight, and occasional measurements of total length, weight and various abdominal dimensions (widths of and second abdominal segments, length of second ominal segment and telson length). Regression equations les and females separately) have been calculated for the owing relationships:

arapace length and total length,
arapace length and total weight,
arapace length and various abdominal dimensions, and otal weight and tail weight.

ause of the number of observations involved, advantage taken of an Elliot 803 computer to calculate the re-ssion equations, and their statistical significance was npared using a Wang Programmable Calculating Ma-ne. The level of significance adopted in the comparisons P=0.05.

*rapace length (mm) and total length (mm)*

The regression equations for carapace length, C, on total gth, L, for males and females separately are:

nales $C = 0.321\ L - 2.42$ (473 observations);
emales $C = 0.313\ L - 1.70$ (222 observations).

A significant difference was found between the slopes of the two regression lines.

This result is in contrast to that reported by Pope and Thomas (1967), who found no significant difference in this relationship between the sexes in *Nephrops* from either the Moray Firth or the Minch. For the purpose of estimating total length from carapace length the following equations can be used:

males $L = 3.02\ C + 10.70$;
females $L = 3.10\ C + 8.35$.

*Carapace length (mm) and total weight (g)*

The relationship between carapace length, C, and total weight, W, ($C = aW^b$) is not linear, but a straight line is obtained after conversion to logarithms:

$$\log_e C = b \log_e W + \log_e a.$$

The following equations were obtained and the slope for males was significantly different from that for females:

males $\log_e C = 0.317 \log_e W + 2.4820$ ( 66 observations);
females $\log_e C = 0.338 \log_e W + 2.4459$ (190 observations).

Carapace length can be converted to total weight from:

males $\log_e W = 3.117 \log_e C - 7.7012$;
females $\log_e W = 2.849 \log_e C - 6.8348$.

In terms of the original measurements:

males $C = 11.96W^{0.317}$
females $C = 11.54W^{0.338}$
males $W = 0.0004523C^{3.117}$
females $W = 0.001076C^{2.849}$

Pope and Thomas (1967) found similar differences between the sexes in Scottish *Nephrops*, the males being heavier than females at corresponding lengths.

*Carapace length* (*mm*) *and various abdominal measurements* (*mm*)

Regression equations were calculated for the relationships between carapace length, C, and the widths of the first and second abdominal segments ($A_1$ and $A_2$ respectively), the length of the second segment, B, and telson length, X. The number of observations in each case was 117 males and 57 females. No significant difference was found between the sexes in any of the relationships, and the equations for both sexes combined are given below:

$C = 1.981\ A_1 + 1.47,$
$C = 2.008\ A_2 + 0.44,$
$C = 3.369\ B + 1.19,$
$C = 2.612\ X - 0.96.$

The similarity of the sexes in the relationship between carapace length and the width of the second abdominal segment is in contrast to the findings of Pope and Thomas (1967), who attributed a sex difference in the same relationship in Scottish *Nephrops* to the broadening of the abdomen associated with egg carrying on the pleopods in the female. The measurement of the second abdominal segment width in the North Shields *Nephrops* did not include the pleu and it is thought that this may have given rise to the ference between these and Scottish *Nephrops*.

The regressions of carapace length on first abdominal ment width, and of carapace length on second abdomi segment width were compared and it was found that, each sex, the slopes were the same but there was a signific difference in their positions.

*Total weight* (g) *and tail weight* (g)

The regressions of total weight, W, and tail weight, T,

males $W = 2.788T + 15.50$ (128 observations);
females $W = 2.882T - 1.92$ ( 40 observations).

The slopes of these lines were the same but there wa significant difference in their positions. Pope and Tho (1967) also found a sex difference in the regressions of t weight and tail weight for Scottish *Nephrops*.

Tail weight can be estimated from total weight from following equations:

males $T = 0.328W + 0.75;$
females $T = 0.342W + 1.58.$

## SEX RATIO AND SPAWNING CYCLE

both the laboratory and market samples, information male and female *Nephrops* was recorded separately. es were also kept on the incidence of berried females in aboratory samples. The sex ratio, that is the percentage les in the total number of *Nephrops*, in three different groups (under 30 mm carapace length, 30 to 39 mm pace length and 40 mm carapace length and over) in the ratory samples for each month, are given in Table 11; lar details of the catches of *Nephrops* sampled on the ket are given in Table 12. The mean monthly values for same size groups in both the laboratory and market ples are shown in Figure 9, together with Storrow's data ch have been examined in the same way.

the under 30 mm carapace length group there was no r seasonal pattern in the sex ratio. Storrow's samples contained a higher proportion of females than the more recent samples, only dropping below 50 per cent in two months of the year (January and September).

In the central size group (30 to 39 mm carapace length), Storrow's data showed females to be more common than males in the catches for nine months of the year, but in the more recent observations there were fewer females than males in most months. In all three sets of data there was a clear reduction in the percentage of females during four months, starting in May in Storrow's and the 1962/67 market data and in June in the 1962/68 laboratory samples.

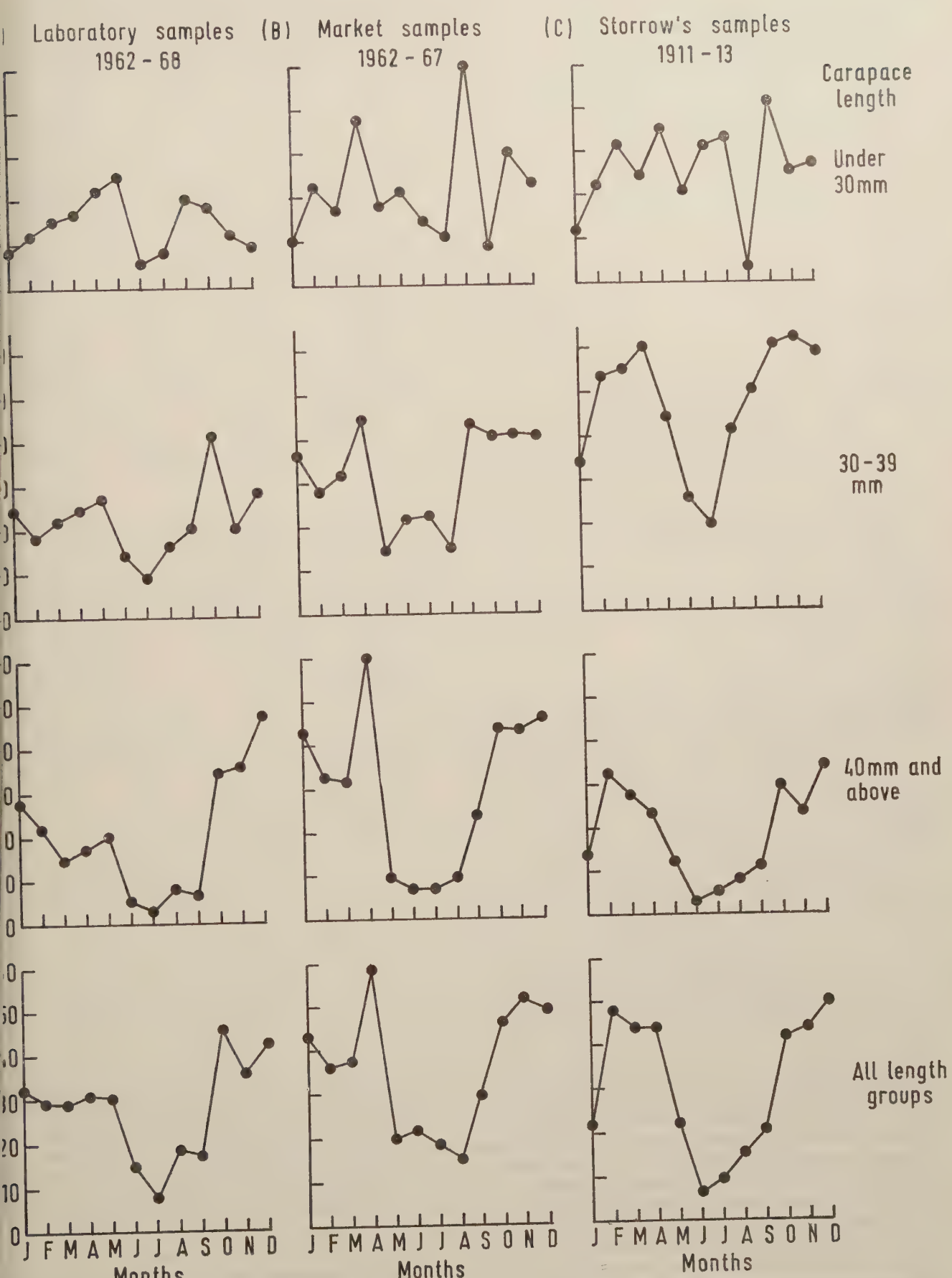
Among the larger *Nephrops* of 40 mm carapace length and over, the paucity of females throughout the year is more marked in all three sets of data and, in the same four months as noted for the medium-sized *Nephrops*, the sex ratio never exceeded 12 per cent.

LE 11 *North Shields* Nephrops; *sex ratio for different size groups in the laboratory samples, 1962–68*

| Month | Carapace length group | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Under 30 mm | | 30–39 mm | | 40 mm and over | | | |
| | % females | Total number | % females | Total number | % females | Total number | % females | Number |
| August | 54.2 | 48 | 52.2 | 113 | 19.0 | 163 | 35.8 | 324 |
| September | 45.5 | 33 | 50.0 | 62 | 12.3 | 155 | 26.0 | 250 |
| October | 46.2 | 104 | 68.9 | 193 | 50.3 | 175 | 57.0 | 472 |
| November | 47.0 | 336 | 31.7 | 293 | 64.5 | 121 | 43.9 | 750 |
| December | 38.1 | 147 | 68.4 | 228 | 86.2 | 188 | 66.4 | 563 |
| January | 37.5 | 136 | 55.3 | 215 | 74.1 | 197 | 57.7 | 548 |
| April | 43.1 | 116 | 48.2 | 245 | 52.8 | 163 | 48.5 | 524 |
| August | 30.8 | 13 | 16.7 | 60 | 6.1 | 132 | 10.7 | 205 |
| October | 46.5 | 99 | 30.1 | 156 | 22.1 | 163 | 30.9 | 418 |
| November | 42.7 | 131 | 28.7 | 331 | 42.2 | 128 | 34.7 | 590 |
| December | 50.0 | 10 | 59.7 | 77 | 54.5 | 213 | 55.7 | 300 |
| January | 45.3 | 232 | 27.3 | 238 | 29.2 | 72 | 35.2 | 542 |
| February | 39.4 | 109 | 20.9 | 277 | 29.8 | 131 | 27.1 | 517 |
| March | 45.9 | 148 | 30.6 | 291 | 30.2 | 126 | 34.5 | 565 |
| April | 42.9 | 28 | 28.6 | 91 | 22.7 | 150 | 26.8 | 269 |
| May | 56.3 | 32 | 27.7 | 130 | 20.9 | 187 | 26.6 | 349 |
| June | 60.9 | 46 | 22.2 | 135 | 8.8 | 226 | 19.2 | 407 |
| August | 0.0 | 4 | 5.3 | 38 | 5.8 | 120 | 5.6 | 162 |
| October | 50.5 | 93 | 39.6 | 149 | 44.2 | 172 | 44.0 | 414 |
| November | 33.3 | 177 | 15.5 | 296 | 28.3 | 106 | 23.3 | 579 |
| December | 41.0 | 83 | 24.2 | 256 | 32.9 | 158 | 29.8 | 497 |
| January | 33.3 | 3 | 10.0 | 50 | 6.4 | 188 | 7.5 | 241 |
| February | 54.5 | 11 | 26.5 | 68 | 32.7 | 171 | 32.0 | 250 |
| March | 62.5 | 16 | 15.9 | 88 | 10.7 | 140 | 16.0 | 244 |
| April | 41.0 | 100 | 15.8 | 266 | 12.2 | 98 | 20.5 | 464 |
| August | 28.3 | 60 | 17.8 | 219 | 2.6 | 192 | 13.0 | 471 |
| September | 55.3 | 38 | 22.0 | 127 | 2.7 | 182 | 15.6 | 347 |
| October | 59.0 | 100 | 37.8 | 249 | 15.5 | 226 | 32.7 | 575 |
| November | 41.2 | 17 | 46.5 | 101 | 34.3 | 198 | 38.6 | 316 |
| December | 32.5 | 40 | 12.9 | 194 | 14.1 | 206 | 15.2 | 440 |
| January | 0.0 | 2 | 10.0 | 50 | 3.2 | 279 | 4.2 | 331 |
| March | 44.6 | 224 | 36.8 | 601 | 12.3 | 300 | 31.8 | 1 125 |
| April | 68.4 | 19 | 28.6 | 98 | 1.5 | 203 | 13.8 | 320 |
| May | 47.1 | 34 | 44.3 | 174 | 19.9 | 201 | 32.5 | 409 |
| July | 37.5 | 8 | 20.5 | 88 | 3.9 | 203 | 9.7 | 299 |
| October | 58.1 | 148 | 77.2 | 346 | 42.9 | 182 | 63.8 | 676 |
| November | 48.4 | 31 | 39.0 | 182 | 23.0 | 248 | 31.0 | 461 |
| February | 34.5 | 165 | 25.5 | 380 | 15.1 | 365 | 23.0 | 910 |
| April | 42.9 | 7 | 32.8 | 61 | 2.9 | 174 | 11.6 | 242 |
| June | 30.0 | 10 | 32.1 | 28 | 0.5 | 189 | 5.7 | 227 |
| July | 33.3 | 3 | 12.9 | 31 | 0.5 | 186 | 2.7 | 220 |
| September | 45.5 | 22 | 24.1 | 58 | 4.2 | 192 | 11.8 | 272 |
| October | 41.6 | 332 | 39.3 | 369 | 34.7 | 118 | 39.6 | 819 |
| November | 40.5 | 420 | 30.3 | 343 | 30.0 | 30 | 35.5 | 823 |
| January | 22.8 | 101 | 30.9 | 304 | 32.7 | 107 | 29.7 | 512 |
| February | 47.3 | 241 | 42.0 | 205 | 12.5 | 96 | 39.1 | 542 |
| March | 26.3 | 19 | 19.4 | 72 | 4.6 | 131 | 11.3 | 222 |
| April | 49.2 | 252 | 43.5 | 271 | 9.1 | 55 | 42.7 | 578 |

TABLE 12 *North Shields* Nephrops; *sex ratio for different size groups in the total catches of the sampled boats, 1962–*

| Year | Month | Carapace length group | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Under 30 mm | | 30–39 mm | | 40 mm and over | | | |
| | | % females | Total number | % females | Total number | % females | Total number | % females | Num |
| 1962 | June | 50.5 | 1 164 | 30.6 | 1 429 | 9.9 | 2 210 | 25.9 | 4 80 |
| | July | 44.4 | 619 | 36.5 | 1 034 | 7.7 | 2 144 | 21.5 | 3 79 |
| | August | 39.5 | 43 | 43.4 | 297 | 9.9 | 1 337 | 16.6 | 1 67 |
| | September | 76.1 | 46 | 66.5 | 814 | 27.5 | 4 803 | 33.5 | 5 66 |
| | October | 24.2 | 1 679 | 54.7 | 5 819 | 49.3 | 6 968 | 48.6 | 14 46 |
| | November | 34.5 | 255 | 49.4 | 1 148 | 45.7 | 1 400 | 46.2 | 2 80 |
| | December | 20.7 | 58 | 21.1 | 298 | 26.2 | 485 | 24.0 | 84 |
| 1963 | January | 36.3 | 1 907 | 59.6 | 6 146 | 64.4 | 10 116 | 59.8 | 18 16 |
| | February | 65.8 | 322 | 74.9 | 994 | 72.9 | 1 795 | 72.8 | 3 11 |
| | April | 70.6 | 936 | 70.0 | 1 748 | 74.5 | 2 051 | 72.1 | 4 73 |
| | August | 40.0 | 25 | 11.9 | 260 | 10.9 | 313 | 12.5 | 59 |
| | October | 42.2 | 102 | 17.4 | 149 | 12.1 | 280 | 19.4 | 53 |
| 1964 | February | 50.0 | 10 | 33.3 | 33 | 23.1 | 39 | 30.5 | 8 |
| | May | 44.4 | 36 | 22.3 | 197 | 5.6 | 409 | 12.9 | 64 |
| | June | 50.0 | 2 | 7.7 | 13 | 9.5 | 63 | 10.3 | 7 |
| | July | 32.5 | 40 | 19.8 | 288 | 9.6 | 460 | 14.5 | 78 |
| | August | 47.2 | 36 | 19.4 | 98 | 6.8 | 250 | 13.8 | 38 |
| | October | 41.8 | 153 | 26.8 | 447 | 19.0 | 547 | 25.1 | 1 14 |
| | November | 42.1 | 38 | 21.4 | 159 | 16.9 | 118 | 22.2 | 31 |
| 1965 | January | 56.0 | 516 | 29.9 | 3 619 | 6.0 | 4 388 | 19.2 | 8 52 |
| | February | 46.5 | 282 | 19.4 | 1 669 | 18.0 | 3 406 | 19.9 | 5 35 |
| | March | 47.6 | 1 141 | 38.8 | 7 119 | 39.9 | 6 848 | 40.0 | 15 10 |
| | April | 61.1 | 725 | 44.0 | 2 844 | 18.6 | 754 | 42.4 | 4 32 |
| | May | 48.2 | 193 | 24.9 | 635 | 10.4 | 632 | 21.7 | 1 46 |
| | June | 40.0 | 20 | 21.0 | 195 | 6.2 | 915 | 9.4 | 1 13 |
| | July | 80.0 | 5 | 16.0 | 75 | 2.3 | 681 | 4.2 | 76 |
| | August | 39.5 | 76 | 20.9 | 494 | 7.4 | 741 | 14.3 | 1 31 |
| 1966 | October | 39.0 | 1 276 | 49.9 | 3 393 | 26.6 | 3 888 | 37.7 | 8 55 |
| | November | 59.6 | 2 174 | 57.1 | 13 123 | 41.6 | 14 001 | 49.9 | 29 29 |
| | December | 60.4 | 1 074 | 55.1 | 8 523 | 46.0 | 7 344 | 51.5 | 16 94 |
| 1967 | January | 35.3 | 538 | 30.5 | 1 778 | 17.4 | 2 729 | 23.9 | 5 04 |
| | February | 47.7 | 796 | 32.6 | 1 428 | 11.8 | 1 190 | 28.9 | 3 41 |
| | March | 44.7 | 369 | 52.7 | 2 328 | 16.5 | 4 147 | 30.3 | 6 84 |
| | June | 51.8 | 110 | 45.8 | 179 | 2.3 | 997 | 12.6 | 1 28 |
| | September | 80.9 | 235 | 38.5 | 722 | 16.5 | 3 965 | 22.8 | 4 92 |
| | October | 51.7 | 1 771 | 48.7 | 6 118 | 51.5 | 5 677 | 50.3 | 13 56 |
| | November | 60.3 | 12 317 | 44.5 | 10 543 | 49.0 | 4 132 | 52.4 | 26 99 |
| | December | 51.9 | 4 625 | 43.2 | 5 813 | 50.2 | 2 462 | 47.7 | 12 90 |


(A) Laboratory samples 1962 - 68
(B) Market samples 1962 - 67
(C) Storrow's samples 1911 - 13
Carapace length
Under 30mm
30 - 39 mm
40mm and above
All length groups
J F M A M J J A S O N D
Months

g. 9 Mean monthly sex ratios of *Nephrops* in three carapace length groups (under 30 mm, 30–39 mm, over 40 mm and all gth groups): (A) laboratory samples, 1962 to 1968; (B) market samples, 1962 to 1967; and (C) Storrow's samples, 1911 to 1913.

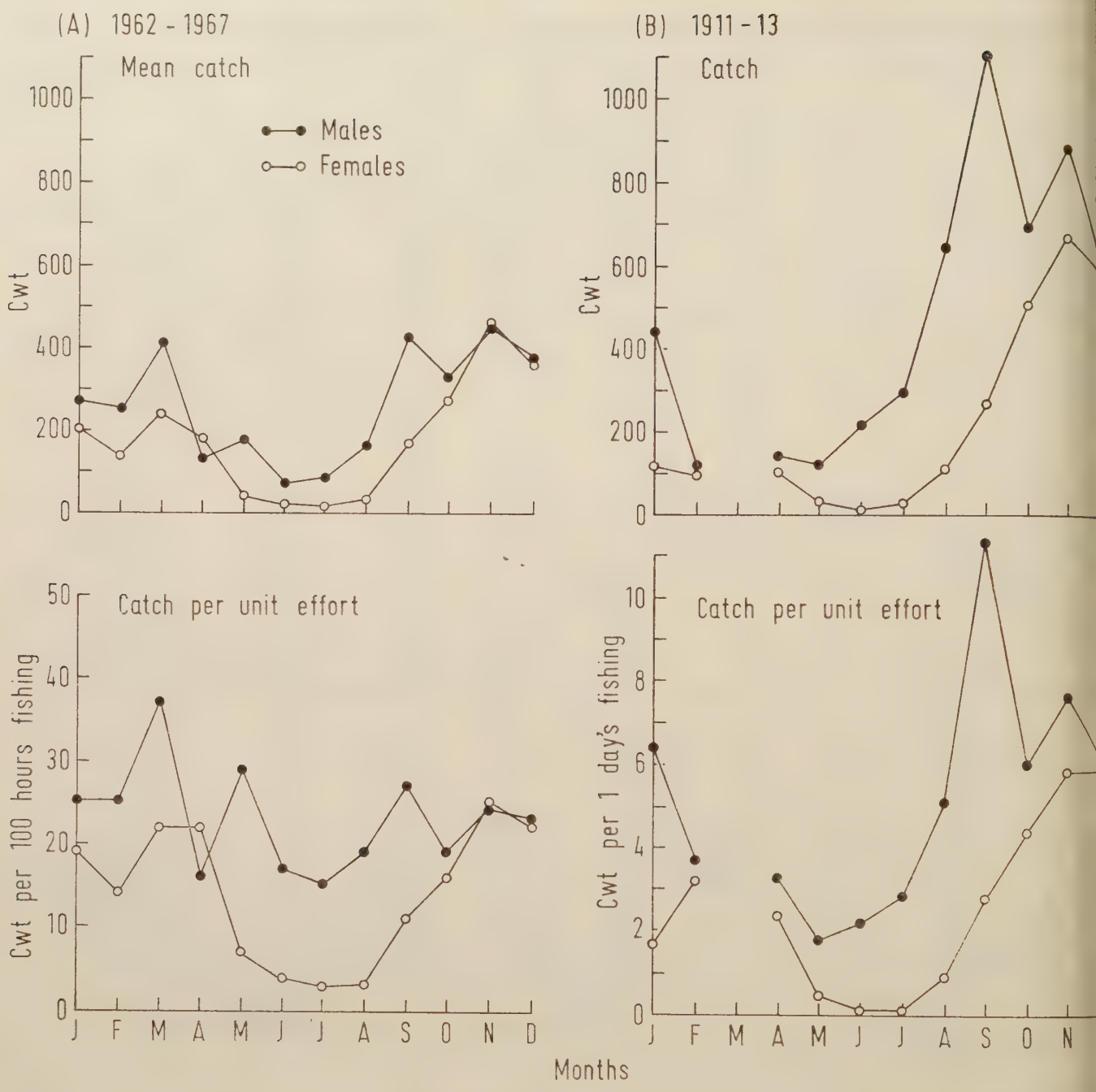



Fig. 10 Mean monthly catches and catches per unit effort of male and female *Nephrops* separately: (A) mark samples, 1962 to 1967; (B) Storrow's samples, 1911 to 1913.

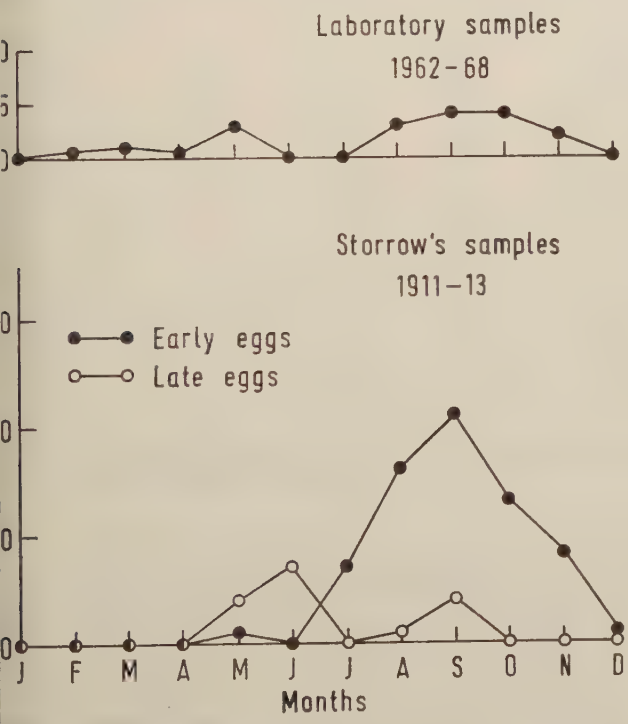
In Figure 10 the monthly sex ratio has been applied to the landings and catch per unit effort at North Shields to give estimates of the monthly landings and catch per unit effort of males and females separately. The landings of both sexes decreased markedly during the early summer and rose to a maximum in the autumn and winter. The catch per unit effort showed similar trends, although these were not so evident in the males during the 1962/67 period. From these results it would appear that there were marked seasonal variations in the availability of the females and, to a lesser extent, the males, as the result of some change in their behaviour.

The numbers of berried females found in the laboratory samples are given in Table 13, and the mean monthly percentages of berried females in the total females sampled are shown in Figure 11, together with Storrow's data for 1911/13. Storrow's results show that *Nephrops* with recently laid eggs were found in May and increased in proporti throughout the summer to reach a maximum in Septemb before falling off to zero in December; *Nephrops* with eg in an advanced state of development were found in Ma June, August and September with the highest proportion June. The stage of egg development of berried *Nephro* sampled in 1962/68 was not recorded, but the seasonal var tions would appear to be similar to those found by Storro although the proportion of berried females was much low The smallest recorded size of females carrying eggs 1911/13 was 23 mm carapace length (of 118 berried indi duals sampled) and in 1962/68 was 27 mm carapace leng (of 104 sampled).

Jorgensen (1925) made some observations on the dist bution of larval *Nephrops* taken in the young fish trawl fro 1½ to 10 miles (2.4 to 16.1 km) off the Northumberland coa She found Stage I larvae in the south of the region (Blyth

13 *North Shields* Nephrops; *numbers of females and berried females in each laboratory sample, 1962–68*

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| females | – | – | – | – | – | – | – | 116 | 65 | 269 | 329 | 374 |
| ed females | – | – | – | – | – | – | – | 2 | 1 | 2 | 0 | 0 |
| females | 316 | – | – | 254 | – | – | – | 22 | – | 129 | 205 | 167 |
| ed females | 0 | – | – | 1 | – | – | – | 1 | – | 3 | 5 | 0 |
| females | 191 | 140 | 195 | 72 | 93 | 78 | – | 9 | – | 182 | 135 | 148 |
| ed females | 0 | 1 | 3 | 1 | 1 | 0 | – | 0 | – | 1 | 1 | 0 |
| l females | 18 | 80 | 39 | 95 | – | – | – | 61 | 54 | 188 | 122 | 67 |
| ed females | 0 | 0 | 1 | 0 | – | – | – | 3 | 1 | 18 | 8 | 0 |
| l females | 14 | – | 358 | 44 | 133 | – | 29 | – | – | 431 | 143 | |
| ed females | 0 | – | 2 | 0 | 6 | – | 0 | – | – | 7 | 5 | |
| l females | – | 46 | – | – | – | 13 | 6 | – | 32 | 324 | 292 | – |
| ied females | – | 0 | – | – | – | 0 | 0 | – | 4 | 26 | 0 | – |
| l females | 152 | 212 | 25 | 247 | – | – | – | – | – | – | – | – |
| ied females | 0 | 0 | 0 | 0 | – | – | – | – | – | – | – | – |
| ırs | | | | | | | | | | | | |
| l females | 691 | 478 | 617 | 712 | 226 | 91 | 35 | 208 | 151 | 1 523 | 1 226 | 756 |
| ied females | 0 | 1 | 6 | 2 | 7 | 0 | 0 | 6 | 6 | 57 | 19 | 0 |
| erried | 0.0 | 0.2 | 1.0 | 0.3 | 3.1 | 0.0 | 0.0 | 2.9 | 4.0 | 3.7 | 1.5 | 0.0 |




11 Mean monthly percentage of berried female *Nephrops*: laboratory samples, 1962 to 1968; (B) Storrow's samples, to 1913.

uet Island) in mid-May, and in mid-August Stage I ae were taken in the extreme north (Burnmouth–Berwick ) when Stage II and III larvae and one post-larva were d further south. These results point to a hatching period least three months' duration (mid-May to mid-August), ough Jorgensen suggested that the larvae could have derived from three distinct sources: (1) those hatched ocal *Nephrops* grounds; (2) those coming from *Nephrops* unds to the north in the region of the Firth of Forth; (3) a few which were freed even further north. A hatching period of at least three months for the North Shields stock agrees well with Storrow's findings of late-berried *Nephrops* in May, June, August and September.

The ovaries of female *Nephrops* taken in the laboratory samples were examined in the fresh condition and classified into seven stages of development according to their macroscopic appearance. Stages O to V inclusive were adapted from Thomas (1964), whose classification was based on material preserved in 4 per cent formalin. An additional stage (VR) was used to identify females in which the ovaries were being resorbed. The corresponding appearance of the stages in fresh material was as follows:

- O no green coloration in the body cavity, the gonad extending into thin lateral filaments;
- I body cavity with no green coloration, the lateral extensions of the gonads broadening out and flattened at the tips;
- II the colourless gonad extending in lobes on either side of the proventriculus; individual eggs distinguishable;
- III the gonad pale green to dark green, extending on either side of the stomach at the anterior end, with a tongue into the first abdominal segment posteriorly; eggs individually distinguishable;
- IV the gonad dark green, extending to the back of the eye socket anteriorly, but not fusing behind the eyes; extending posteriorly into the second abdominal segment;
- V the gonad dark green, filling the whole of the body cavity and fusing behind the eyes; running into the third or fourth abdominal segment; and
- VR ovaries being resorbed, hollow; may be very dark in coloration.

The percentages of ovaries in each stage of maturation during each month of 1962 to 1968 inclusive are given in Table 14 and the mean monthly values in Figure 12.

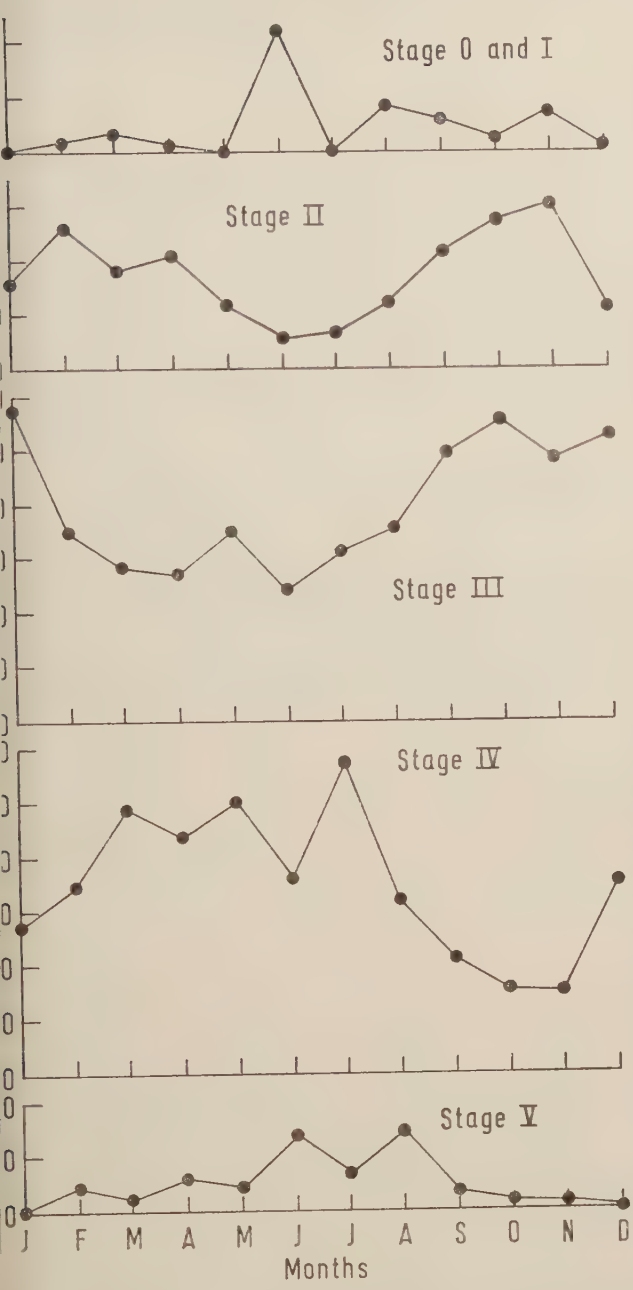
TABLE 14 *North Shields* Nephrops; *percentage maturity of females in each laboratory sample, 1962–68*

| Year | Month | Maturity stage | | | | | | Number sample |
|---|---|---|---|---|---|---|---|---|
| | | O | I | II | III | IV | V | |
| 1962 | August | 3.3 | 7.7 | 5.5 | 34.1 | 33.0 | 16.5 | 91 |
| | September | – | 14.1 | 10.9 | 45.3 | 21.9 | 7.8 | 64 |
| | October | 1.1 | 2.7 | 13.4 | 59.9 | 21.0 | 1.9 | 262 |
| | November | 3.4 | 19.6 | 32.7 | 36.1 | 8.3 | – | 327 |
| | December | – | 0.3 | 12.8 | 52.9 | 34.0 | – | 374 |
| 1963 | January | – | – | 11.1 | 55.9 | 33.0 | – | 315 |
| | April | – | – | 9.9 | 35.3 | 54.0 | 0.8 | 252 |
| | August | – | 25.0 | 5.0 | 20.0 | 50.0 | – | 20 |
| | October | – | 2.3 | 27.9 | 62.0 | 7.0 | 0.8 | 129 |
| | November | – | 2.0 | 22.5 | 51.0 | 21.6 | 2.9 | 204 |
| | December | – | 1.2 | 3.0 | 59.9 | 35.9 | – | 167 |
| 1964 | January | – | – | 31.4 | 61.3 | 7.3 | – | 191 |
| | February | – | 3.6 | 12.9 | 37.1 | 44.3 | 2.1 | 140 |
| | March | – | 5.7 | 18.2 | 37.5 | 36.5 | 2.1 | 192 |
| | April | – | 5.6 | 11.1 | 25.0 | 47.2 | 11.1 | 72 |
| | May | – | – | 9.7 | 11.8 | 67.7 | 10.8 | 93 |
| | June | 2.6 | 19.7 | 5.3 | 23.7 | 35.5 | 13.2 | 76 |
| | August | – | – | 33.3 | 44.4 | 22.2 | – | 9 |
| | October | – | 5.5 | 30.8 | 34.1 | 28.6 | 1.1 | 182 |
| | November | – | 1.5 | 28.1 | 34.1 | 31.1 | 5.2 | 135 |
| | December | – | 2.7 | 12.2 | 36.5 | 46.6 | 2.0 | 148 |
| 1965 | January | – | – | 5.6 | 22.2 | 72.2 | – | 18 |
| | February | – | 1.3 | 8.9 | 13.9 | 48.1 | 27.8 | 79 |
| | March | – | – | 2.6 | 7.9 | 89.5 | – | 38 |
| | April | – | 4.3 | 22.6 | 12.9 | 21.5 | 38.7 | 93 |
| | August | – | – | 20.7 | 39.7 | 24.1 | 15.5 | 58 |
| | September | – | – | 22.2 | 48.1 | 29.6 | – | 54 |
| | October | – | 3.7 | 23.8 | 57.7 | 13.8 | 1.1 | 189 |
| | November | 0.8 | 0.8 | 19.7 | 72.1 | 4.9 | 1.6 | 122 |
| | December | – | 1.5 | 22.7 | 60.6 | 15.2 | – | 66 |
| 1966 | January | – | – | 7.1 | 85.7 | 7.1 | – | 14 |
| | March | – | 2.5 | 20.6 | 24.0 | 51.5 | 1.4 | 359 |
| | April | – | – | 25.0 | 45.5 | 29.5 | – | 44 |
| | May | – | – | 12.0 | 50.4 | 37.6 | – | 133 |
| | July | – | – | 3.4 | 34.5 | 55.2 | 6.9 | 29 |
| | October | – | – | 22.0 | 59.2 | 16.7 | 2.1 | 431 |
| | November | – | – | 13.4 | 65.5 | 21.1 | – | 142 |
| 1967 | February | – | – | 20.3 | 58.0 | 21.7 | – | 207 |
| | April | – | – | 35.7 | 25.0 | 39.3 | – | 28 |
| | July | – | – | 16.7 | 16.7 | 66.7 | – | 6 |
| | September | – | – | 37.5 | 59.4 | 3.1 | – | 32 |
| | October | – | – | 43.7 | 51.7 | 4.3 | 0.3 | 323 |
| | November | – | – | 44.5 | 44.9 | 10.6 | – | 292 |
| 1968 | January | – | – | 6.6 | 55.9 | 37.5 | – | 152 |
| | February | – | – | 46.9 | 17.2 | 35.9 | – | 209 |
| | March | – | – | 12.0 | 48.0 | 40.0 | – | 25 |
| | April | – | – | 33.2 | 22.7 | 43.7 | 0.4 | 247 |

*Nephrops* with ovaries in Stages O to I were relatively scarce throughout the year except in June, but the number of females sampled in this month was small. Stage II ovaries were common in September, October and November, and the proportions of Stage III ovaries reached over 45 per cent from September to January inclusive and fell to a minimum of 24 per cent in June. Stage IV ovaries were found in their greatest proportions in the period March to July inclusive, whereas Stage V ovaries, although not common at any time of the year, were present in significant numbers from April to August inclusive. Female *Nephrops* in maturity Stage VR were not found in the laboratory samples although they were observed in the larger samples on board research vessels.

The carapace length composition and mean length of each maturity group are given in Figure 13. An increase in the modal length group and mean length was seen for each succeeding stage of ovary maturation. Few females in Stages O, I and II were found above 33 mm carapace length, whereas the majority of females in Stages III, IV and V were 28 m carapace length and over. The size of first maturity cann be deduced from these results, since the seasonal cycle gonad maturation of *Nephrops* after first spawning is n known. However, from Table 15, which gives the size co position of each gonad maturity stage of berried *Nephro* caught in August to November inclusive (which are main recently berried), it is seen that, following egg-laying, mo gonads were in Stage II or III, indicating that Stages O an were immature stages and that once sexual maturity h been attained, the ovaries reverted back to Stage II or on egg-laying. Table 15 also shows that berried females maturity Stage II were all relatively small (below 37 m carapace length), whereas those in Stage III ranged fro 28 to 52 mm carapace length.

It would appear from these results on gonad maturatio larval distribution and incidence of berried females that t spawning cycle of *Nephrops* on the North Shields groun was similar to that of stocks in the Irish Sea (O'Riorda




12 Mean monthly percentage of *Nephrops* ovaries in each of maturation, laboratory samples, 1962 to 1968.

LE 15 *North Shields* Nephrops; *length frequency of each maturity stage of females carrying recently laid eggs, 1962–67, August to November inclusive*

| Carapace length (5 mm groups) | Maturity stage | | |
|---|---|---|---|
| | II | III | IV |
| 23–27 | 1 | 1 | 1 |
| 28–32 | 22 | 15 | – |
| 33–37 | 11 | 11 | – |
| 38–42 | 2 | 7 | – |
| 43–47 | – | 13 | – |
| 48–52 | – | 3 | – |
| Total | 36 | 50 | 1 |
| Mean length (mm) | 32.4 | 38.0 | 25.5 |

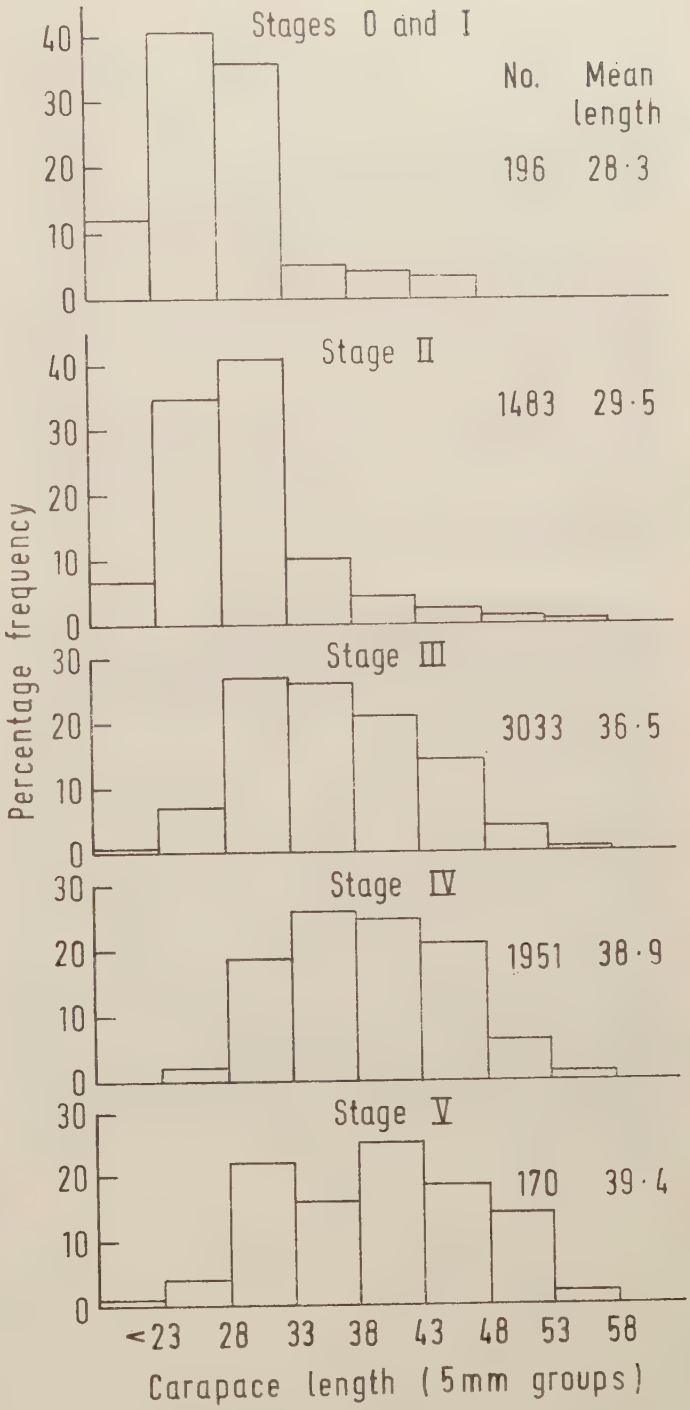



Fig. 13 Percentage length composition of female *Nephrops* in each maturity group, laboratory samples, 1962 to 1968.

1964) and around Scotland (Thomas and Figueiredo 1965). That is, the eggs were laid during the summer and autumn (mainly from July to November, with a peak in September) and hatching occurred in the following spring and summer (May to August). These workers related the sex ratio in the catches to this spawning cycle, and showed that the proportion of females was low in winter during the egg-carrying stage (when they were, for some reason, less liable to capture) and high in the summer when in the non-berried stage. The incidence of berried females in the North Shields catches certainly decreased rapidly during the winter after its maximum in September but, in contrast to other British stocks, the proportion of females found in the North Shields fishery both by Storrow and in the present investigations was low in the summer months and high in winter. These seasonal changes in sex ratio were not due to an increase in the pro-

portion of small immature female *Nephrops* in the catches from North Shields grounds during the winter months, since they were most evident in the larger size groups (30 mm carapace length and above), as was the case on Scottish grounds, and were not found in the smaller size group. Thomas and Figueiredo (1965), when discussing Storrow's results, suggested that these differences in sex ratios between the North Shields and other British fisheries may have been due to exceptional circumstances during the one year of sampling (May 1911 to April 1912), or that the sampling, which was confined to commercial catches, was not representative. However, the present data from commercial vessel sampling were obtained over a period of seven years (1962 to 1968) and these are in agreement with Storrow's results. In addition, Cole (1965) found that the size composition of *Nephrops* on the North Shields grounds, as indicated by the catches of *Nephrops* trawls fitted with small-meshed covers, differed very little from that sampled on the North Shields market.

From the high percentage of non-berried females found during the winter months, Storrow (1912) suggested that breeding on the North Shields grounds does not take place every year, but Thomas and Figueiredo (1965) pointed out that berried females mostly disappear from the catches, and that Storrow's conclusion was therefore open to doubt. However, some support for Storrow's thesis is given by the 1962/68 results on the sex ratio of the larger size groups, which show that mature unberried females are well represented (between 34 and 47 per cent) in the landings at North Shields during October, November and December when *Nephrops* are normally most abundant, indicating that there are large numbers of females which do not spawn every year. On the other hand, the high percentage of *Nephrops* in Stages IV and V from March to August inclusive, unless they can remain in these late stages of maturation for some considerable time, points to an annual spawning. The results of the present investigations are therefore inconclusive on the spawning frequency of *Nephrops* from the North Shields fishery.

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Plate 1. The arrangement of tanks used to isolate the newly hatched larvae of *Palaemon serratus*.

Plate 2. Wooden tanks used for the outdoor culture of *Palaemon serratus* juveniles. Each compartment measured 1.2×1.2×0.3 m deep.